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REPORT OF THE ARCTIC ICE OBSERVING AND FORECASTING PROGRAM—1970

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ABSTRACT

The ice program conducted by the Naval Oceanographic Office in the North American Arctic during 1970 is presented. Methods of collection and dissemination of ice data, ice forecasting, forecast verification, and ice observations by satellite are discussed. Sea ice distribution in the eastern Arctic was normal or slightly heavier than normal. Conditions for escorted and unescorted entry into five ports occurred as predicted or two to five days later than forecast. Ice conditions in the western Arctic were heavier than normal for the second consecutive year, especially along a portlon of the northern Alaskan coast where the width of the shore lead did not exceed 40 miles during summer. Ice conditions, including both aerial and satellite data in the eastern and western sectors of the Arctic, are shown graphically in separate appendixes.

G. J. POTOCSKY

Applications Research Division Ocean Science Department

FOREWORD

This report, the nineteenth of an annual series, summarizes the ice program conducted during 1970 by the Naval Oceanographic Office principally in support of Military Sealift Command resupply operations in the eastern Arctic and Commander Alaskan Sea Frontier in the western Arctic. Ice data were acquired by aerial reconnaissance, icebreakers, and from satellite photographs and were used for ice forecasting. Satellite ice information not only supplements aerial reconnaissance but provides repetitious coverage that is required to observe movement of ice edges and the opening or closing of leads. These data, together with other historical information, make possible a comprehensive accumulation of ice information which is an asset in preparation of ice forecasts and is necessary to the overall efficient planning and successful execution of arctic operations.

F. L. SLATTERY

Captain, U.S. Navy

Commander

GB2595 .UE 1970

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PART I - EASTERN ARCTIC

1. GENERAL

Resupply of the eastern Arctic during 1970 was conducted by the Military Sealift Command (MSC). MSC ships carried bulk cargoes to Goose Bay, Sondre Stromfjord, Itivdleq, Thule, and Kulusuk. These locations and other place name references in the text are presented in figure 1. For presentation purposes, the North American Arctic is divided into three major regions each of which is subdivided into ice reconnaissance areas as shown in figure 2. The eastern region was resupplied by MSC, the western region by commercial shipping, and the central region by the Canadian Department of Transport (DOT).

2. ICE FORECASTING

The U.S. Naval Oceanographic Office (NAVOCEANO) conducted a long-range ice forecasting program in support of MSC eastern Arctic operations. This program included the long-range seasonal ice outlook* and 15- and 30-day forecasts used to amend the long-range outlook. Short-range 48-hour and 5-day forecasts and ship ice routings were provided by the Naval Weather Service.

a. Long-Range Ice Outlook

The long-range ice outlook for the eastern Arctic was designed to provide an estimate of ice conditions during the resupply season for planning a generalized and tentative arctic shipping schedule. The outlook was based initially on evaluation of oceanographic and climatic factors affecting ice formation, growth, and drift. Forecasts of ice disintegration and predicted trends were then based on comparison of this evaluation with historical data.

In addition, a comprehensive aerial survey of the Labrador Sea, Davis Strait, and Baffin Bay from 17 through 21 March provided information on distribution, age, and topography of the ice. Data extracted from ESSA 9 photographs between 19 and 21 March supplemented aircraft data in the Labrador Sea and Davis Strait and provided information for the east Greenland coast. The current environment was compared to historical ice conditions to determine possible analogies. After incorporation of this information, predicted trends for the opening of the various ports were related to normal dates when ice concentrations would permit ships to safely enter these ports with and without icebreaker assistance.

^{*}U.S. Naval Oceanographic Office, The Eastern Arctic Ice Seasonal Outlook, 1970, H.O. SP-60(70). April 1970.

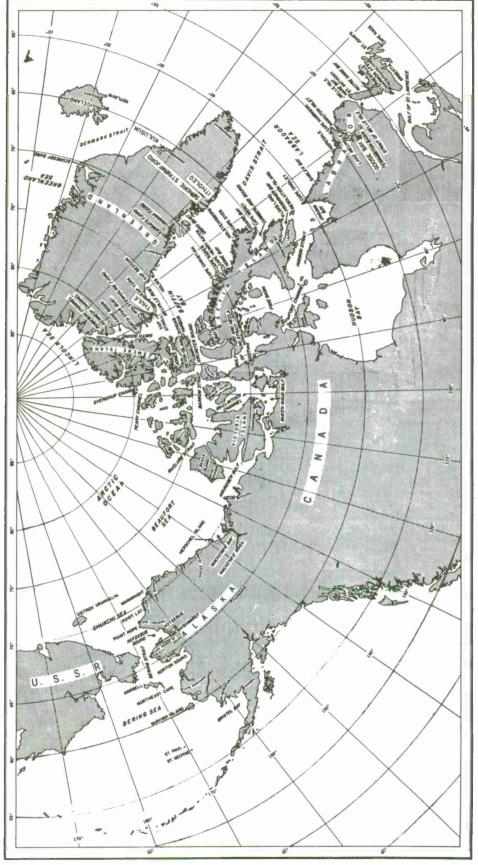


FIGURE I PLACE NAME CHART

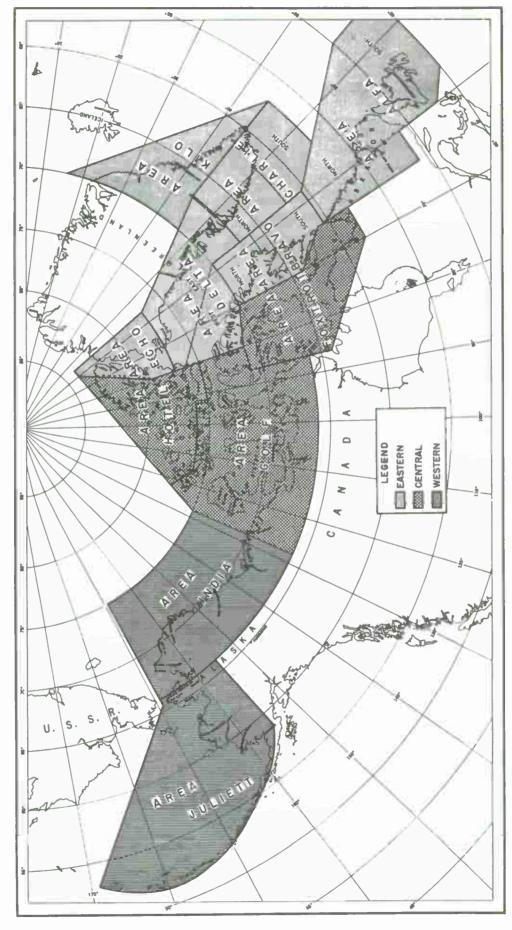


FIGURE 2 RESUPPLY AND ICE RECONNAISSANCE AREAS

b. Fifteen- and Thirty-Day Ice Forecasts

Fifteen- and 30-day forecasts were issued from NAVOCEANO via radioteletype (RATT) twice monthly between 30 May and 20 November. These forecasts were revisions of the long-range outlook and contained more detailed information on ice edge, concentration, and floe size. Forecasts were based on aerial reconnaissance, satellite data, historical ice information, and ESSA 30-day prognostic charts of the mean sea-level pressure and 700-millibar-height departure from normal. Commencing with 5 October, the 15- and 30-day forecasts were freezeup forecasts. Forecasts are summarized in table 1.

Table 1

Fifteen- and Thirty-Day Ice Forecasts
Eastern Arctic, 1970

		Num	ber	
Site-Area	Period	15-Day	30-Day	Total
Goose Bay-Labrador Sea	20 May-20 June 5 Nov-20 Nov	4	3	7
Sondre Stromfjord	20 May- 5 June 5 Nov	3	1	4
Thule-Baffin Bay	20 May- 5 Aug 5 Oct-20 Nov	10	9	19
Kulusuk-Denmark Strait	20 Jun- 5 Aug	<u>3</u> 20	$\frac{4}{17}$	$\frac{7}{37}$

c. Short-Range Ice Forecasts

Forty-eight-hour and 5-day forecasts were issued by the Fleet Weather Facility, Suitland, Maryland. Ice advisories and forecasts commenced when ships entered operational areas and terminated when shipping was completed or when the ice was no longer a hazard to shipping.

d. Ship Ice Routes

In order to minimize ice damage to shipping, ice routing service was provided by Fleet Weather Central, Norfolk, Virginia. Optimum track ship routes were provided from the last port of call in the Atlantic to arctic ports and return. During the periods of icebreaker escort, routes were terminated at a rendezvous point in the port approaches.

3. ICE RECONNAISSANCE

Long-range aerial ice reconnaissance of the eastern Arctic was provided by P3A aircraft stationed at Bermuda. A summary of regular flights

and hours flown over each reconnaissance area each month, including transit time, is given in table 2. Flight hours for each mission were apportioned to the various reconnaissance areas. Immediate tactical support was provided by icebreaker-based helicopters which made local ice observations.

Table 2

Ice Reconnaissance Flights, Eastern Arctic, 1970

Month	Flts.	Total Hours	ALFA	BRAVO	CHARLIE	DELTA	ЕСНО	KILO	Hours of Ice Obs.
March	5	32.6	12.1	2.9	4.9	12.7	0	0	18.3
May	4	33.2	6.5	6.6	4.6	6.1	1.8	0	13.2
June	11	78.8	35.6	6.1	6.6	15.1	3.3	0	27.6
July	18	121.3	22.7	7.4	3.4	53.2	0	0	43.5
Aug	4	33.5	4.3	2.1	0	4.1	0	18.1	10.9
Oct	2	14.1	3.7	1.9	0	4.3	0	0	2.9
Nov	4	25.3	4.7	2.5	2.0	7.1	0	0	7.4
Totals	48	338.8	89.6	29.5	21.5	102.6	5.1	18.1	123.8

Several other sources of ice reconnaissance over the eastern Arctic augmented the data obtained by P3A flights. These included 10 U.S. Coast Guard flights listed in table 3, in which Navy ice observers participated. Other supplementary ice reconnaissance data covered initial and terminal legs of Project BIRDS EYE missions and Danish ice reconnaissance conducted primarily along the south and east Greenland coasts including 90 flights totaling 447 hours. Some Canadian observations in Baffin Bay and Labrador Sea were also utilized.

Table 3

Participation in U.S. Coast Guard Flights, 1970

Month	Flts.	Total Hours	ALFA	BRAVO	CHARLIE	DELTA	Hours of Ice Obs.
Jan	2	12.7	6.2	3.5	3.0	0	6.8
Feb	2	10.6	10.6	0	0	0	8.4
Mar	2	11.5	11.5	0	0	0	4.9
Sep	1	5.6	0	0	0	5.6	2.8
Oct	_3	21.0	O	2.7	2.0	16.3	6.8
Totals	10	61.4	28.3	6.2	5.0	21.9	29.7

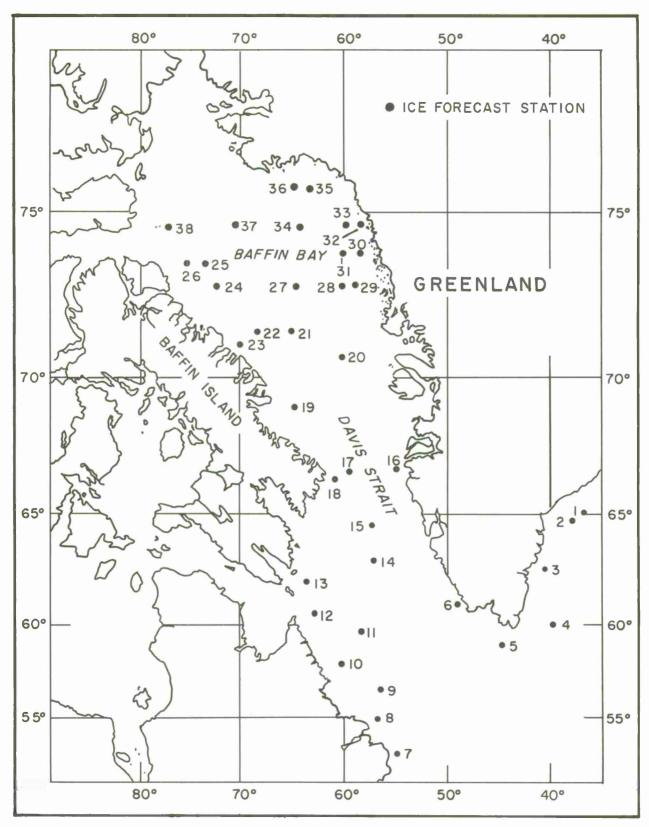


FIGURE 3 OCEANOGRAPHIC STATIONS OCCUPIED BY USCGC SOUTHWIND, OCTOBER 1970

4. SUPPORTING PROJECTS

a. Oceanography

During October, the USCGC SOUTHWIND occupied 38 oceanographic stations in Baffin Bay, Davis Strait, Labrador Sea, and along the east Greenland coast south of 65° N. The location of these stations are presented in figure 3.

b. Project BIRDS EYE

In conjunction with research and development of ice forecasting techniques for the Arctic Basin and to provide ice forecasting support, Project BIRDS EYE consisted of a series of six ice reconnaissance missions with several flights in each mission over the North American Arctic. BIRDS EYE missions totaling 51 flights for 480 hours were conducted on standard tracks primarily over the Arctic basin.

c. Barents Sea and Kara Sea Operations

During July, August, and September, 14 satellite ice messages and two 15-day ice forecasts were sent to the SOUTHWIND for use in oceanographic operations in the Barents and Kara Seas.

d. East Greenland Operations

During July and August, three 15-day ice forecasts of the pack edge and ice concentrations within the ice edge along the east Greenland coast were provided to Commander Task Group 87.1 for operations north of 70°N between the east Greenland coast and Spitsbergen.

5. OBSERVED ICE CONDITIONS

Ice conditions observed by aerial reconnaissance in the eastern North American Arctic are presented in appendix A. Ice data were obtained primarily from U.S. aerial ice reconnaissance, including BIRDS EYE flights, supplemented by U.S. Coast Guard flights and Danish reconnaissance. Ice conditions observed by satellite in the eastern North American Arctic are presented in appendix B.

Fast ice in Itivdleq and Sondre Stromfjord broke up later than normal, as forecasted by the outlook, owing to low temperatures during the preceding winter. However, the unescorted trends for Itivdleq and Sondrestrom were 2 days later than forecast. Ice concentration in the approaches to Goose Bay decreased to less than six-eighths by 11 June, 2 days later than forecasted in the outlook. Southerly drift of ice resulted in a 20- to 30-mile-wide band across the approaches to Hamilton Inlet during the first week in July. Unescorted entry to Goose Bay was therefore delayed until 6 July, four days later than predicted. Ice concentration

in the Thule approaches decreased to less than six-eighths by 15 July, resulting in normal escorted entry into Thule. Although the ice in Baffin Bay was well weakened during the remainder of July and early August, open-water conditions did not develop until 11 August owing to lack of strong winds to break up the remaining ice. Thus, the later-than-normal unescorted entry date was 9 days later than forecast in the outlook.

From mid-May to mid-June the pack ice south of 70°N through Denmark Strait to the Kulusuk approaches was near normal. By the first week in July southerly ice drift and disintegration considerably narrowed the pack southward from 70°N. Escorted entry into Kulusuk was normal, as predicted by the outlook and verified by aerial reconnaissance. Satellite data indicated that ice disintegration in the Kulusuk approaches and northward along the coast continued at a normal trend. Unescorted entry was possible by 21 August, the normal entry date as predicted by the outlook. Verification of the long-range outlook is given in table 4.

PART II - WESTERN ARCTIC

1. GENERAL

During the 1970 resupply season in the western Arctic, short-range ice forecasting support was provided by the Naval Weather Facility at Kodiak, Alaska. NAVOCEANO was responsible for providing long-range forecasts in support of military and oceanographic operations.

Table 4
Long-Range Ice Outlook Verification, 1970

Escorted Entry*

Port	Normal	Predicted Trend	Observed
Itivdleq	17 April	Later (5 to 9 days) Later (2 to 5 days) Normal (+ 4 days) Normal (+ 4 days) Normal (+ 4 days)	26 April
Sondre Stromfjord	29 May		2 June
Goose Bay	5 June		11 June
Thule	12 July		15 July
Kulusuk	14 July		12 July
	Unescorte	ed Entry**	
Itivdleq	1 May	Later (5 to 9 days) Normal (+ 1 day) Later (5 to 9 days) Later (5 to 9 days) Normal (+ 4 days)	12 May
Sondre Stromfjord	7 June		10 June
Goose Bay	23 June		6 July
Thule	23 July		11 August
Kulusuk	18 August		21 August

^{*}Concentration in approaches 6/8 or less and fast ice, if any, in port well weakened.

^{**} Concentration in approaches and port 1/8 or less.

2. ICE FORECASTING

Fifteen- and 30-day ice forecasts for the north Alaskan coast and the Bering and Chukchi Seas were issued to COMALSEAFRON twice monthly throughout the year. Forecasts included information on ice pack edges, concentrations, stages of development, and ice thickness for six specified points. Forty-eight 15- and 30-day forecasts were issued.

3. ICE RECONNAISSANCE

Aerial reconnaissance was conducted over areas INDIA and JULIETT by P3A aircraft stationed at Adak. Additional ice data were obtained by utilizing flights by the Arctic Research Laboratory (ARL) from Point Barrow and Project BIRDS EYE flights from Eielson AFB, Fairbanks, Alaska. A summary of P3A flights and hours flown, including ARL missions, for each month over each area and annual totals is presented in table 5. Flight hours for each mission were apportioned to reconnaissance areas INDIA and JULIETT.

4. OBSERVED ICE CONDITIONS

Ice conditions observed by aerial reconnaissance in the western North American Arctic are presented in appendix C. The data were obtained primarily by scheduled aerial reconnaissance and were supplemented by BIRDS EYE flights. Ice conditions observed by satellite in the western North American Arctic are presented in appendix D.

Table 5

Ice Reconnaissance Flights, Western Arctic, 1970

Month	No. of Flts.	Total Hours	INDIA	JULIETT	Hours of Ice Obs.
Jan	1	10.2		10.2	5.2
Feb	2	19.5	2.6	16.9	8.0
Mar	1	8.4	5.9	2.5	1.8
June	2	15.0	6.6	8.4	7.2
July	9	40.8	40.8	0	30.1
Aug	7	29.8	29.8	0	23.8
Sep	3	12.8	12.8	0	9.6
Dec	1	5.8	0	5.8	4.1
Totals	26	142.3	98.5	43.8	89.8

PART III - SATELLITE OBSERVATIONS

1. GENERAL

Ice information, including ice edges, concentrations, and large leads or water openings, was interpreted from satellite photographs between 3 March and 5 October. The data for the eastern and western Arctic and Canadian Archipelago are presented in appendixes B and D, respectively.

Ice data derived from ESSA 9 and ITOS I photographs may disagree with aerial reconnaissance data in some cases; however, discrepancies do not always indicate incorrect satellite ice information. Ice edges may be plotted incorrectly owing to navigational problems aboard the aircraft. The width of the ice pack sometimes appears less extensive in a satellite photograph than the width shown on an aerial reconnaissance chart for the same area during an equivalent time period. This specific discrepancy is due to the interpreter's inability to observe ice of less than 3 oktas concentration along an ice edge in the current series of satellite photographs. Leads and large openings observed within the pack ice are labeled "ice free to 3 oktas," unless the analyst was well assured that the area contained no ice, in which case the area was labeled "ice free." The notation "ice free to 3 oktas" generally infers that the center of the area is ice free and that concentrations of 1 to 3 oktas of ice are present along the periphery of the area.

Concentrations within the pack were interpreted by the analyst without reference to aerial reconnaissance data. Concentrations cannot be interpreted to the nearest okta with current resolution, except for fast ice; therefore, concentrations are analyzed in ranges of oktas as shown in appendixes B and D. Analysis of ice conditions covered by extensive cloud cover or under conditions of poor illumination was not possible; therefore, areas of arctic darkness or extensive cloud cover are labeled with the appropriate symbols. Ice edges can be observed occasionally through thin cloud cover; however, the concentrations are difficult to ascertain. In such cases, a cloud symbol outlines the pack ice and terminates at the ice edge.

Continuous satellite coverage of the Arctic, along with consistent interpretation of the satellite data, permits observation of significant changes. Movement of ice edges, opening and closing of flaw or shore leads, changes of concentration, and gradual expansion of large water openings, such as the North Open Water, can be observed.

2. DISSEMINATED SATELLITE DATA

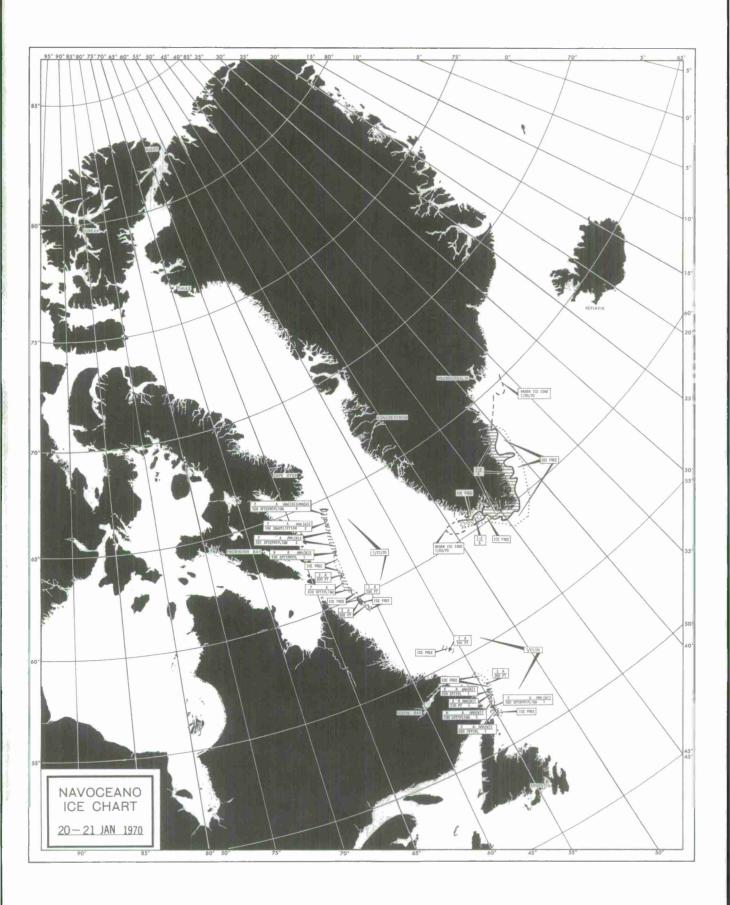
From 28 May until 1 October NAVOCEANO prepared 19 charts showing ice edges, concentrations, and water openings in the eastern Arctic. These

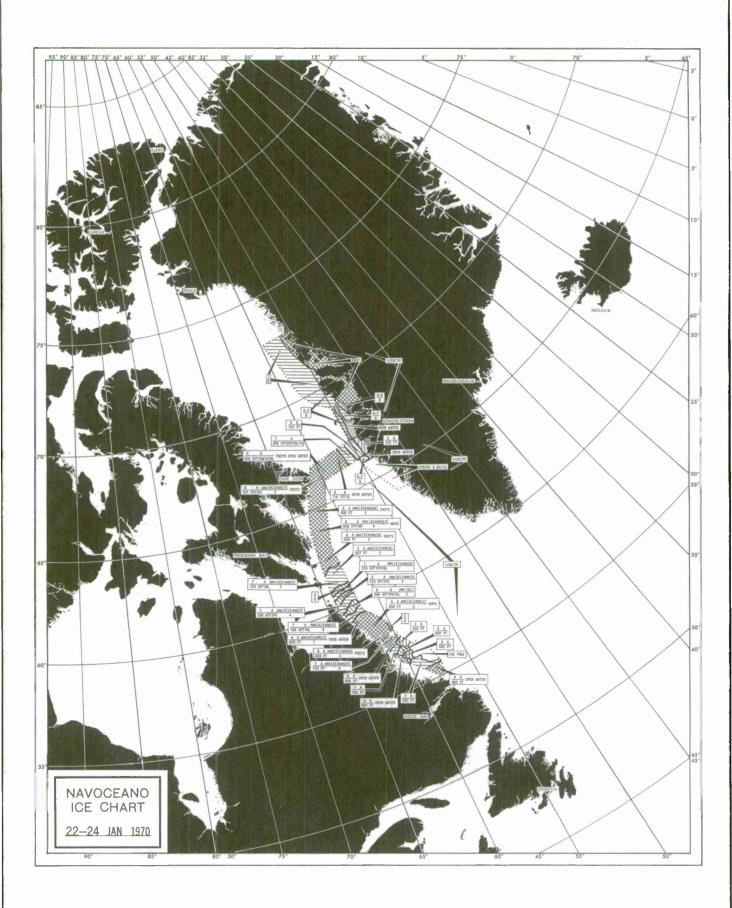
charts were transmitted weekly by facsimile to MSC resupply ships and icebreakers. Ice charts were produced from interpreted satellite data for the eastern and western Arctic and the Canadian Archipelago. A total of 437 charts was mailed to various government agencies. Data were also extracted from these charts and transmitted via radioteletype (RATT) message to icebreakers and cognizant commands.

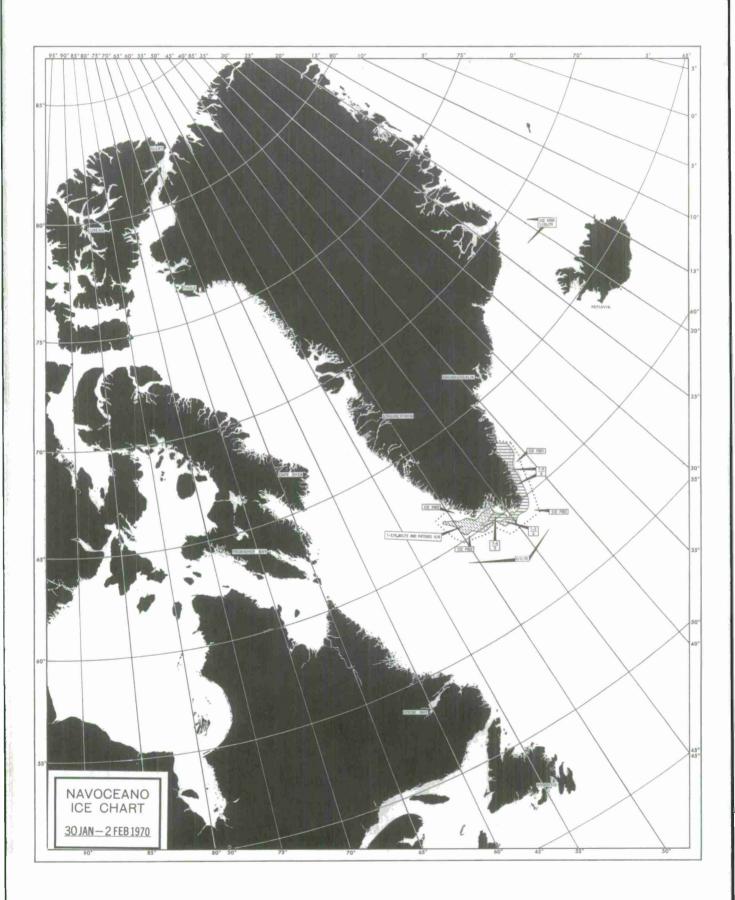
APPENDIX A EASTERN ARCTIC ICE CHARTS OBSERVED BY AERIAL RECONNAISSANCE

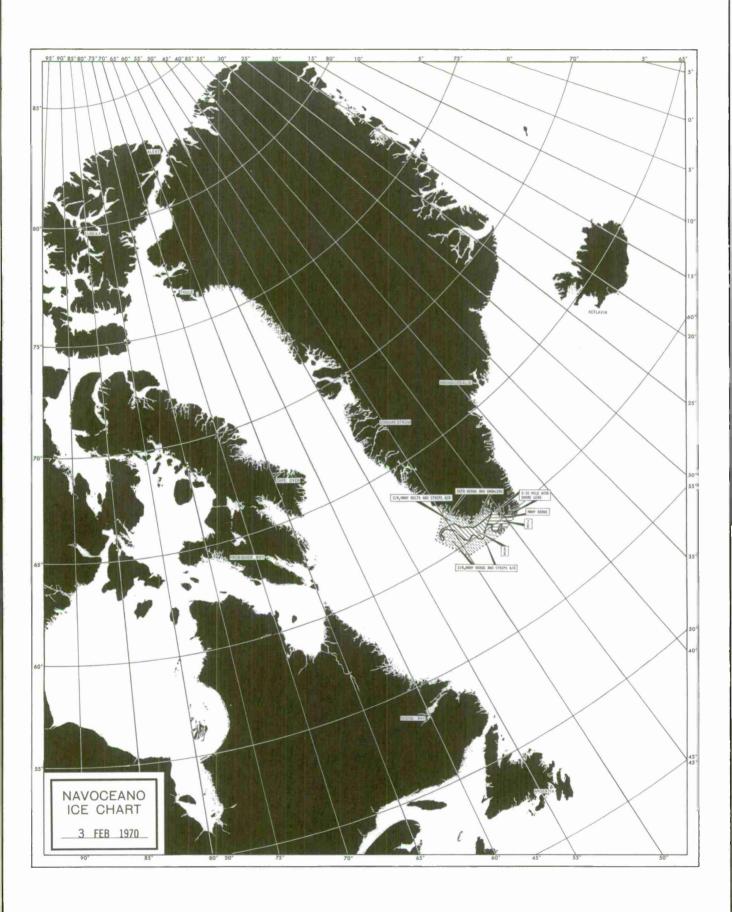
KEY TO ICE SYMBOLS USED IN PLOTTING ICE FEATURES

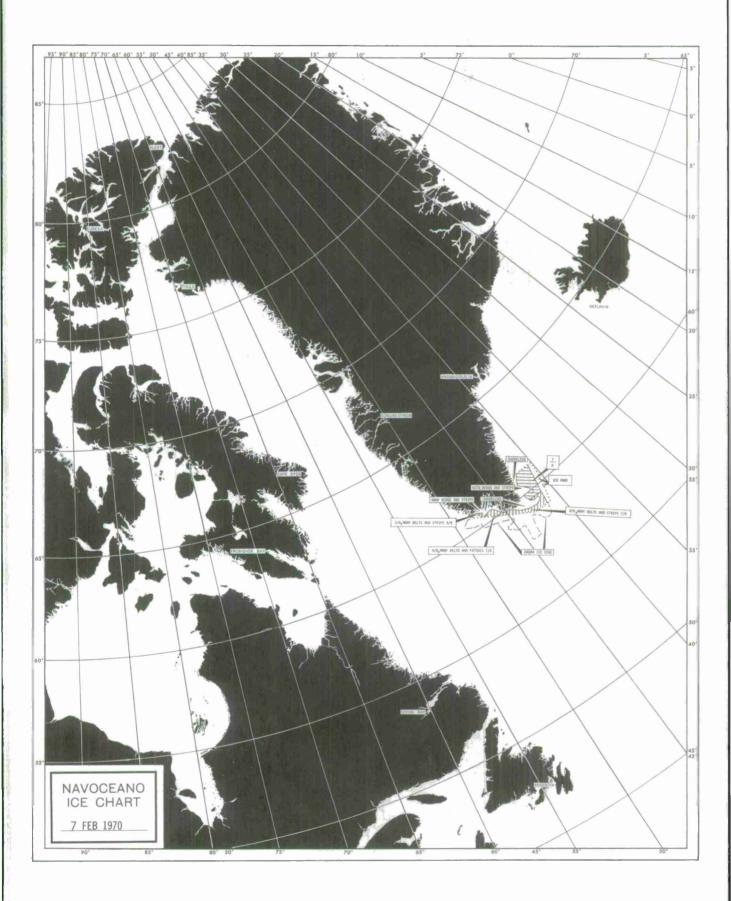
TOTAL CONCENTRATION **TOPOGRAPHY** CONC = Concentration A Rafted or Finger-Rafted Ice Ice free CRK = Crack ()() Hummocks <1 okta* (open water) CRKS = Cracks **/**√\(N) New Ridges 1-<3 oktos FRCT = Fracture M (W) Weathered Ridges FRCTV = Very Small Fracture (very open pack) M(V) Very Weathered Ridges FRCTS = Small Fracture 3-<6 aktas FRCTM = Medium Fracture M(A) Aged Ridges (open pack) FRCTL = Large Fracture M(C) Cansolidated Ridges 0 6-<7 oktas LVL = Level Ice (close pack) **///** (N) (h) Example: NDTR = Not Determined 7-<8 oktas NOPG = No Openings in Ice (very close pack) OPWR = Open Water (h) height af ridges in meters 8 oktas SCTD = Scattered (n) tenths caverage an ice (compact pack) SD = Snow Depth = Ice Thickness T STAGE OF MELTING **COVERAGE BY SIZE** FPD = Few Puddles C MPD = Mony Puddles 010203 FTH = Few Thaw Holes C = total cancentration MTH = Mony Thaw Holes SS/NL = New Ice or Nilas DRI = Dried Ice n_1 PK = Pancoke < 3 m ROT = Rotten Ice FLO = Flooded Ice CK = Brosh, Small Cake, Coke < 20 m SF = Small Floe 20-100 m MF = Medium Flae 100-500 m **UNDERCAST** BF = Big Floe 500-2000 m. CCC Limit VF = Vost Floe 2-10 km $^{\rm n}$ 3 GF = Giant Floe > 10 km Fast = Fast Ice THICKNESS OF ICE & SNOW Example: 7 = tatal concentration 7 1 = okta all pancake ice t_F = ice thickness in cm 124 2 = oktas small and medium ice flaes s = snaw depth in cm 4 = oktos big, vost, and giant ice floes STAGE OF DEVELOPMENT **PHENOMENA** A ***** crack oktas predominant, oktas secondary **AVERAGE THICKNESS** fracture fracture AGE SS = Frazil, Grease, Slush, Shuga palynya NL = Ice Rind, Dork Nilas, Light Nilos - - < 5-10 cm≥ lead G = Gray _____10—15 cm GW = Gray-White _ _ _ _ _ 15-30 cm △(n) icebergs ---- 30-70 cm FL = Thin First-Year (n) bergy bits & grawlers FM = Medium First-Year --- 70-120 cm ---->120 cm FT = Thick First-Year (n) = number in greg SY = Second-YearMY = Multi-Year ICE EDGE Exomple: A abserved 5FM3G _____ rador A = Stage of development 5FM = 5 oktos Medium First-Year • • • • • limit of 3G = 3 oktas Gray observed data *One okta equals one-eighth ice concentration •---• satellite data



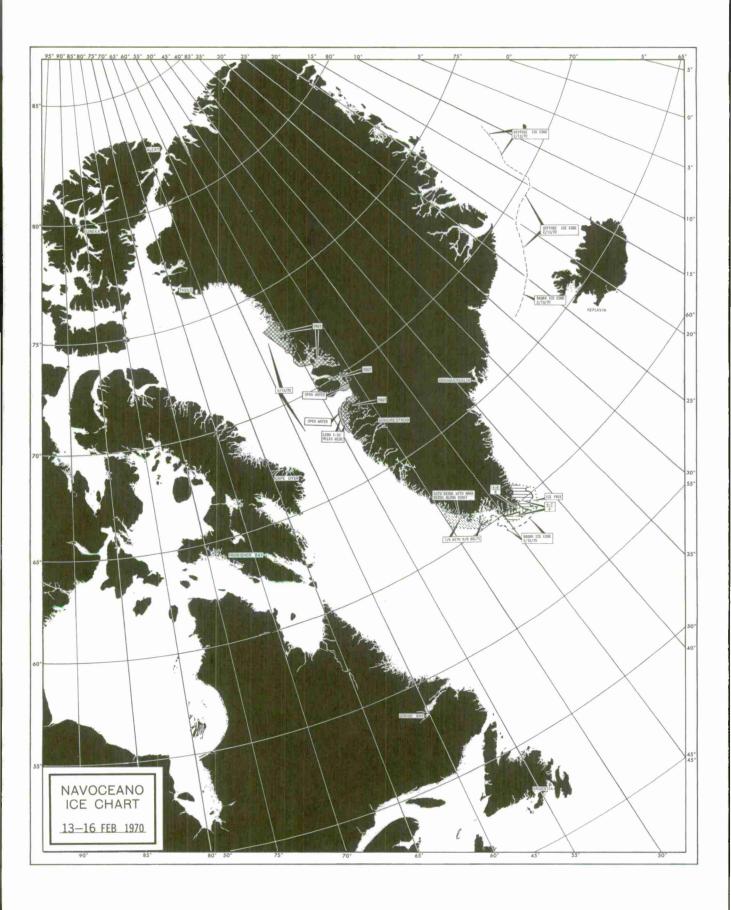


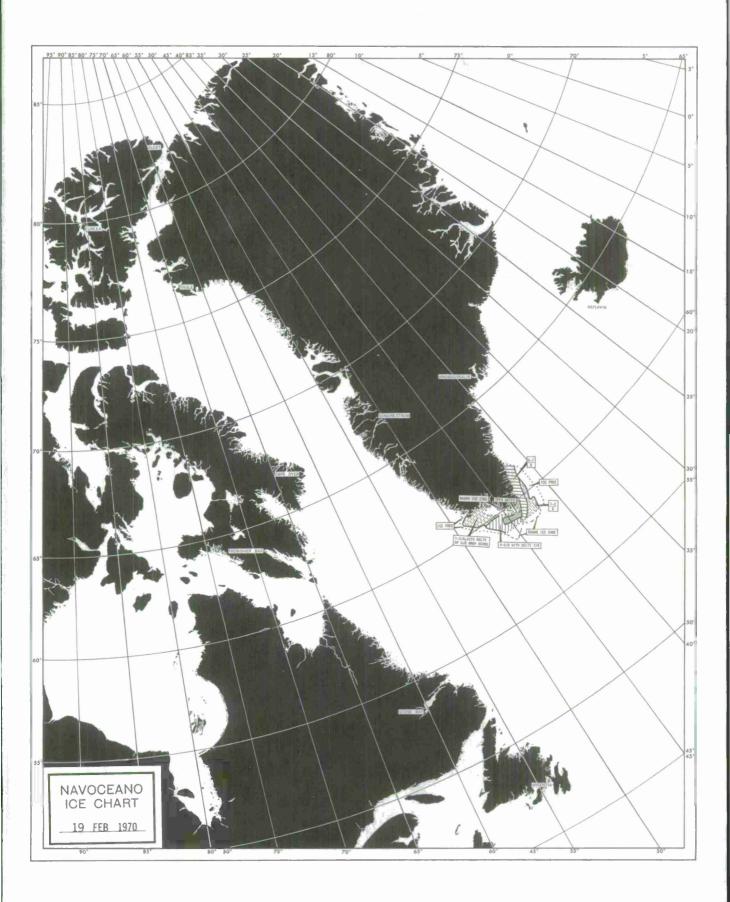


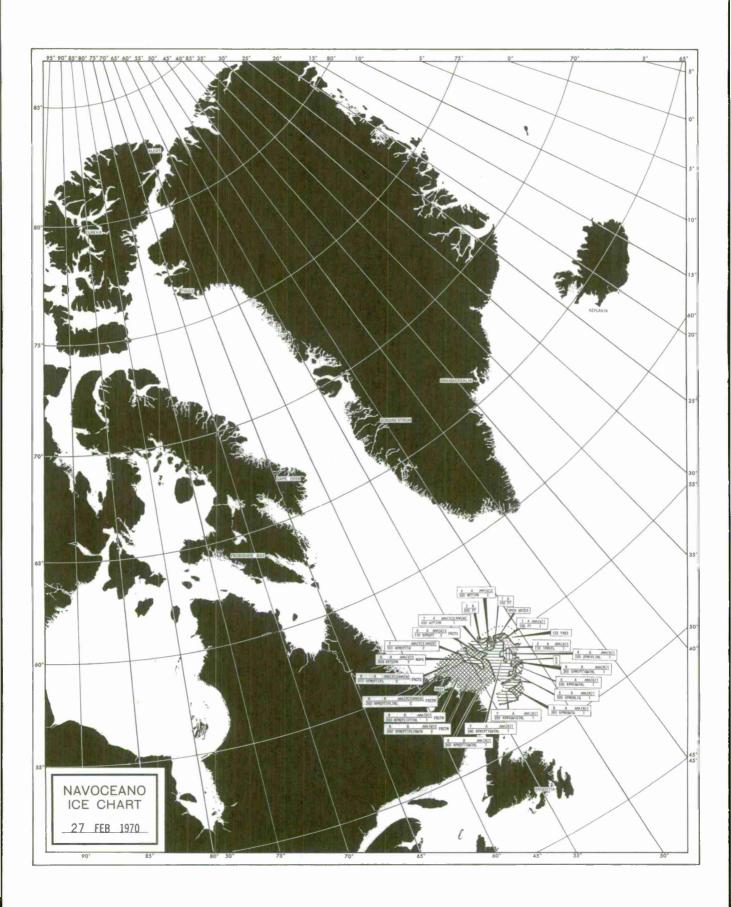


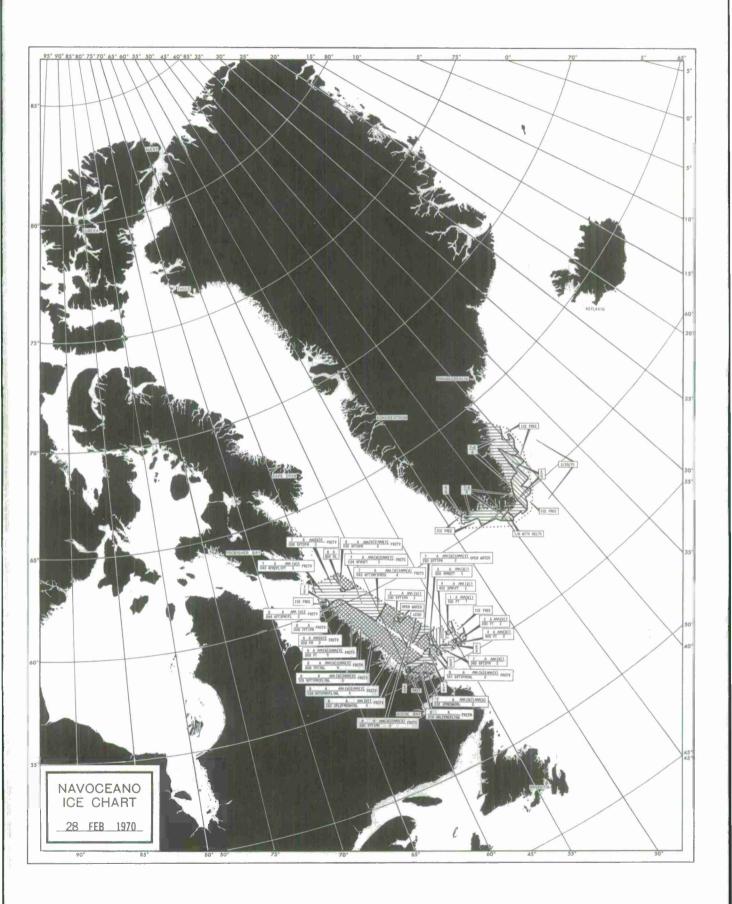


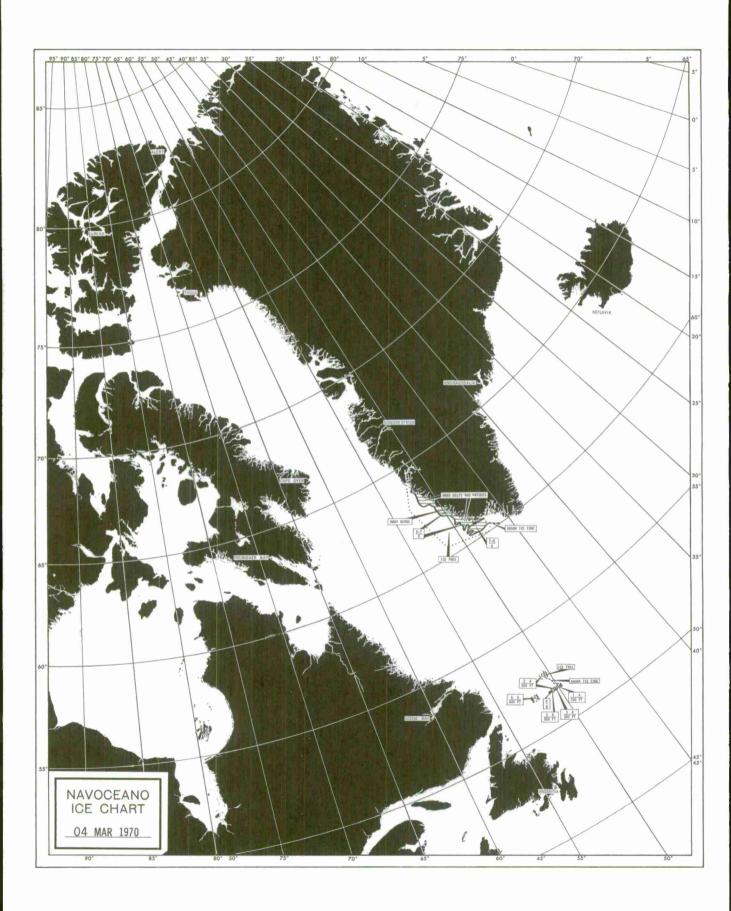
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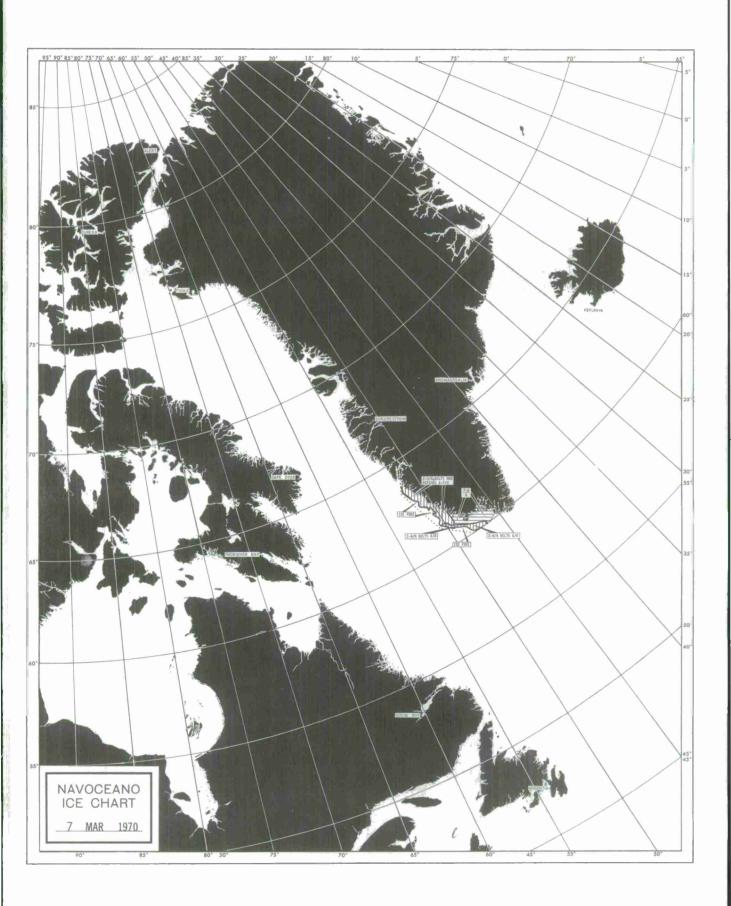


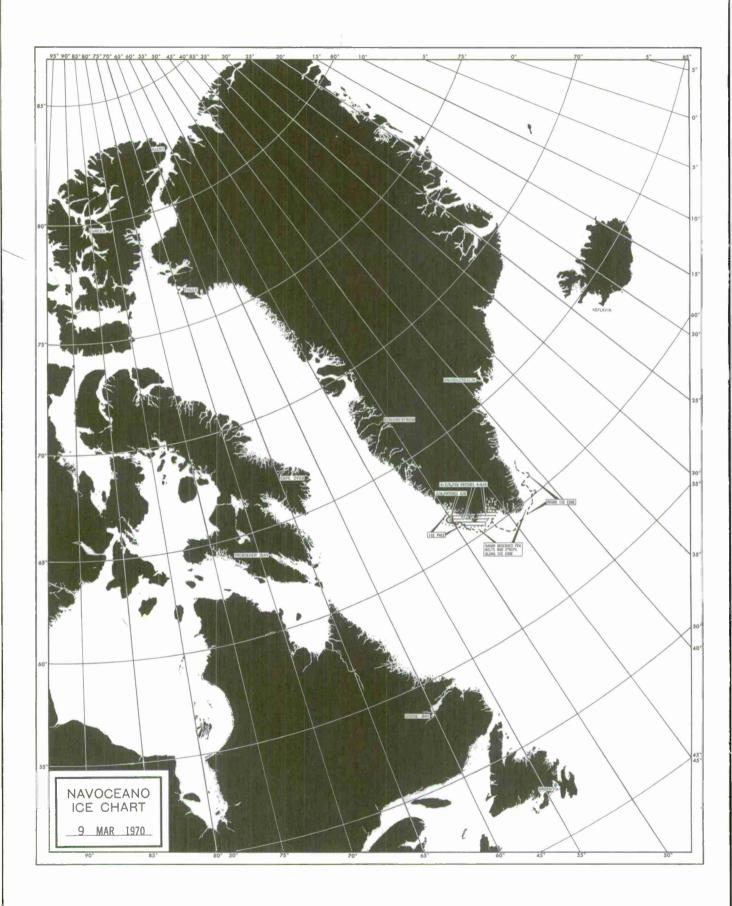


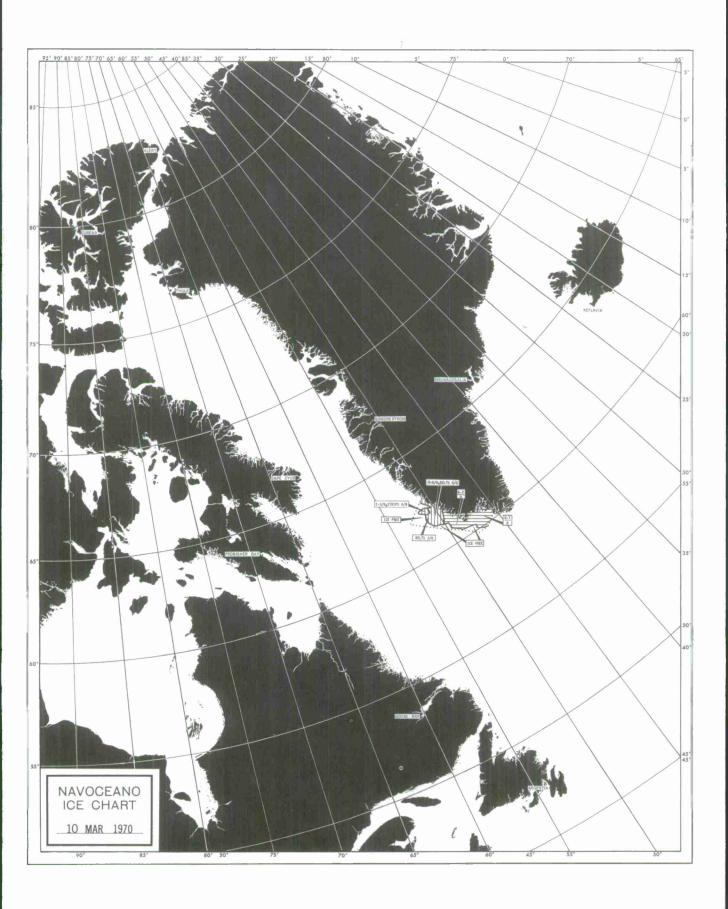


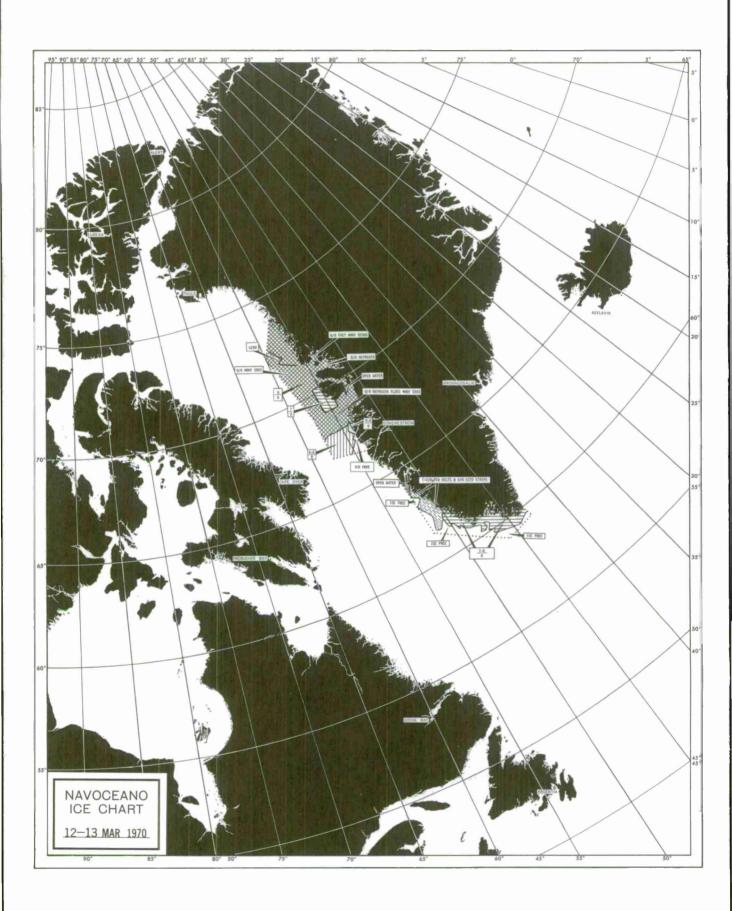


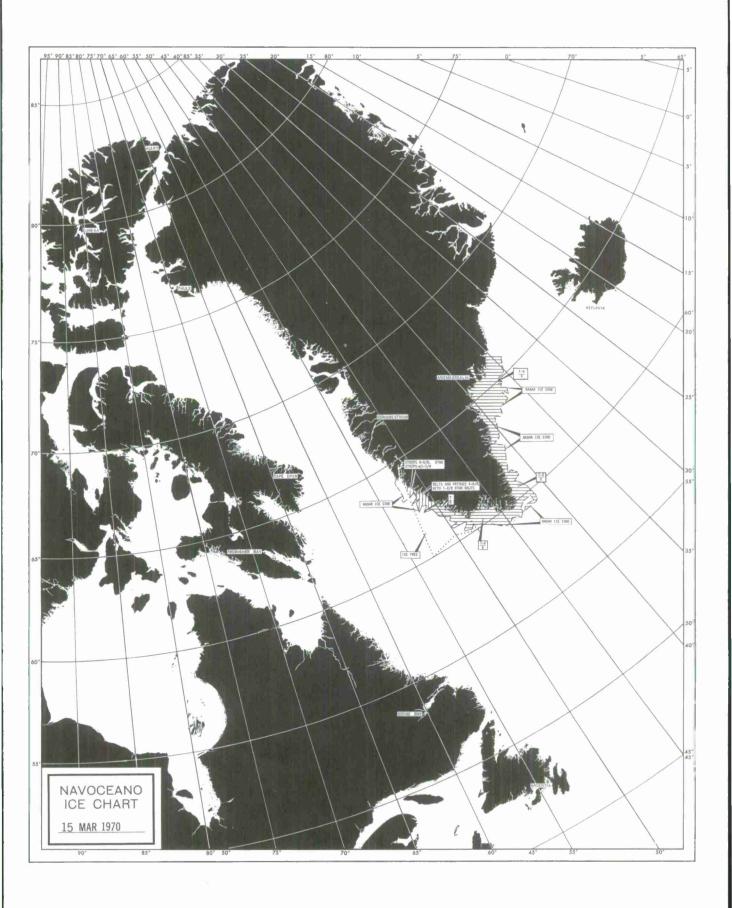


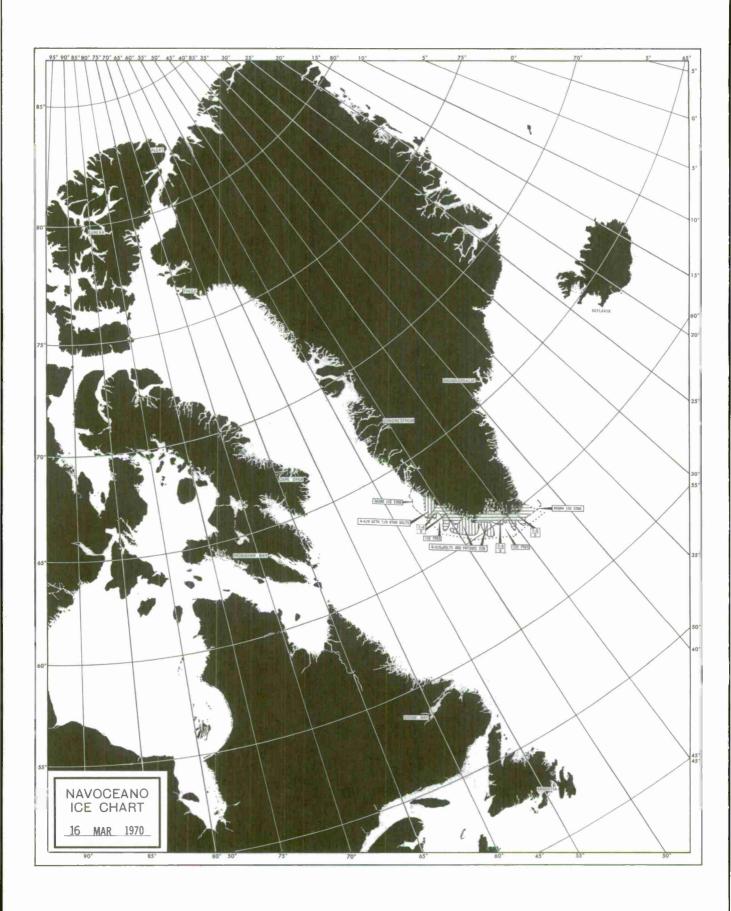


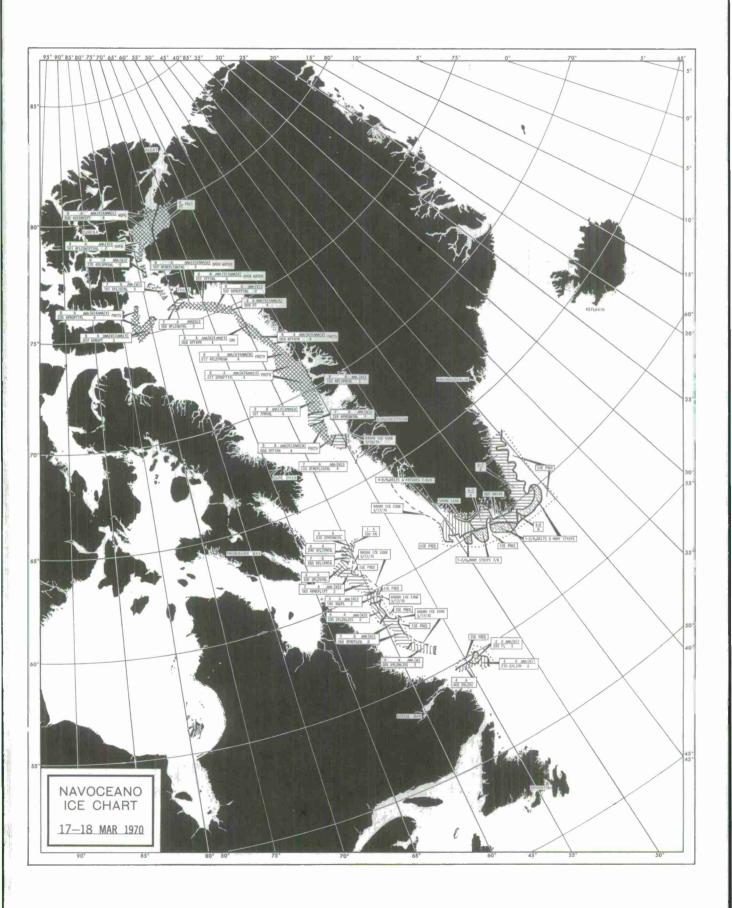


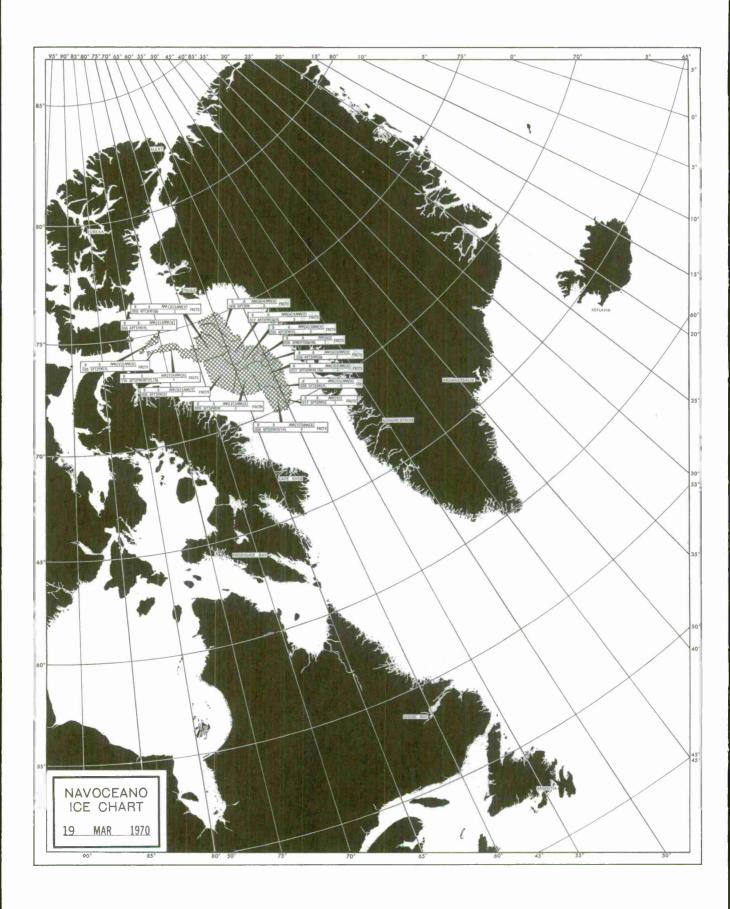


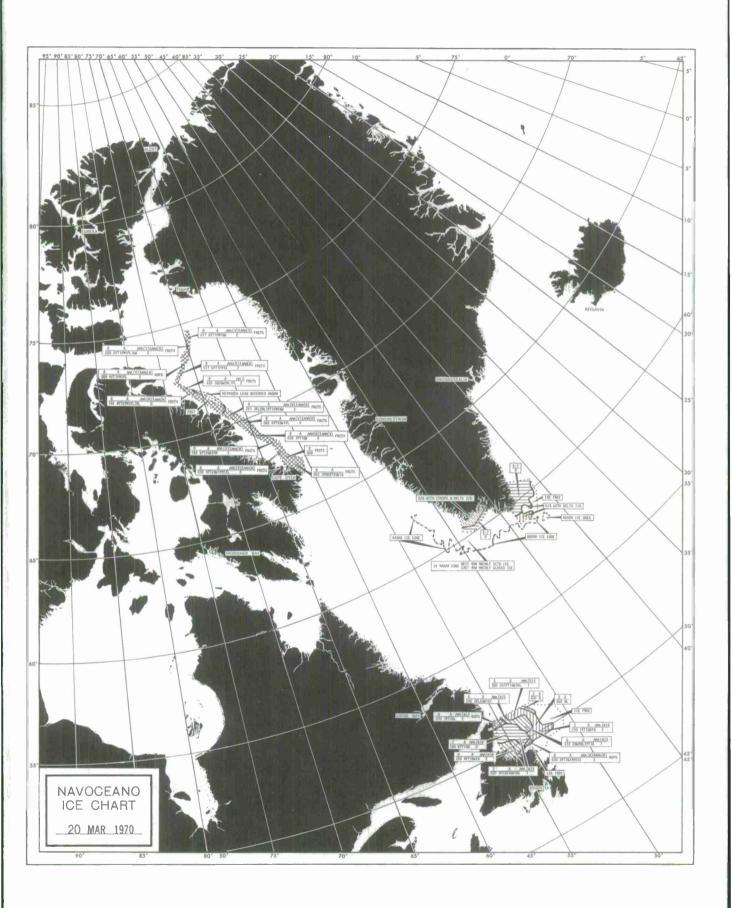


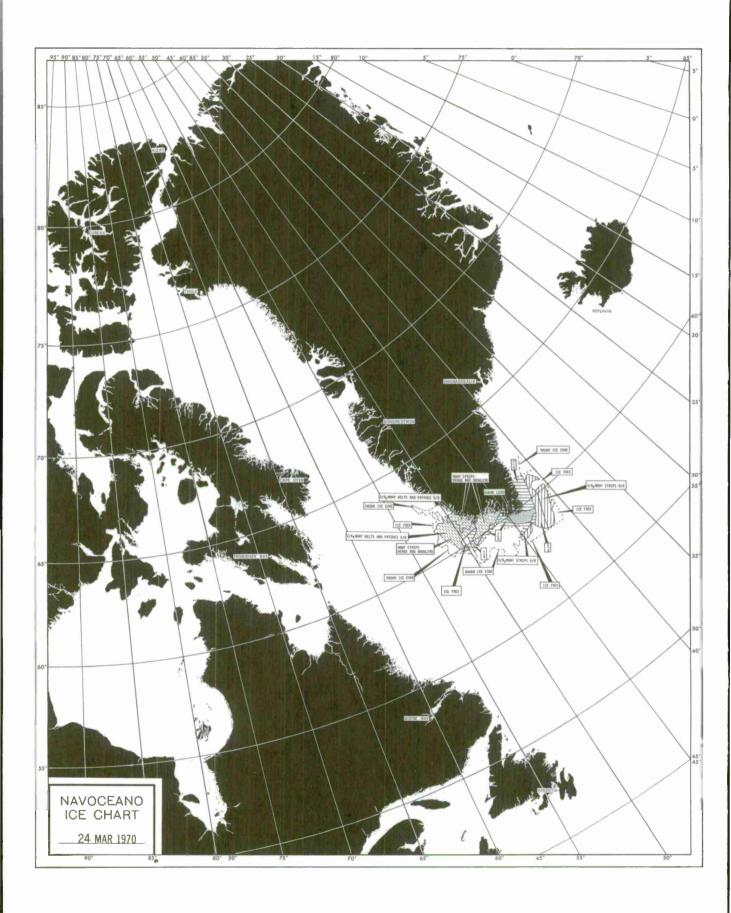


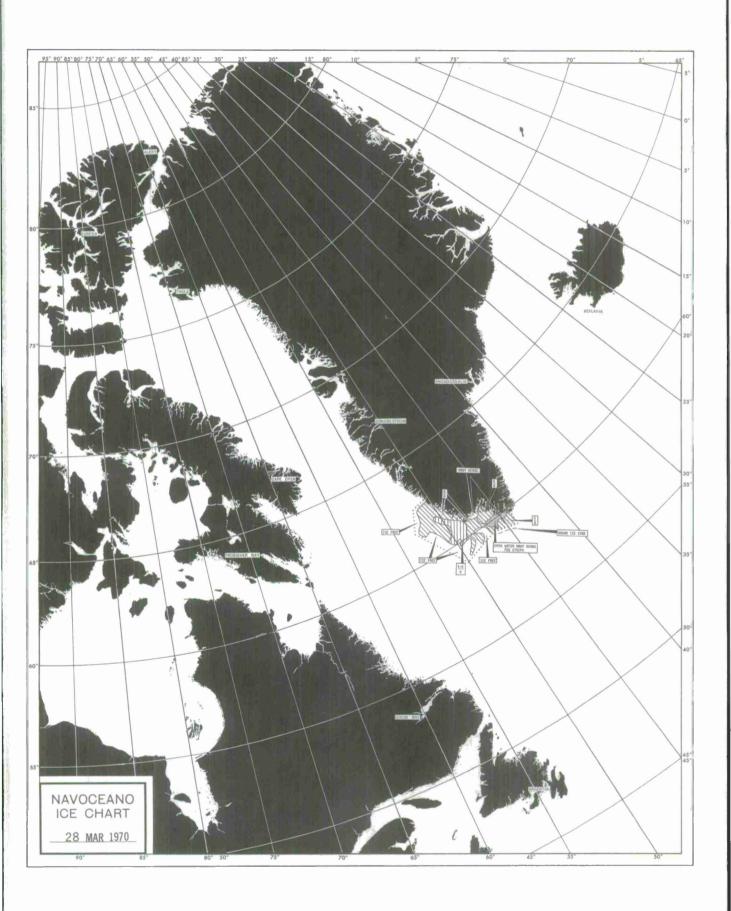


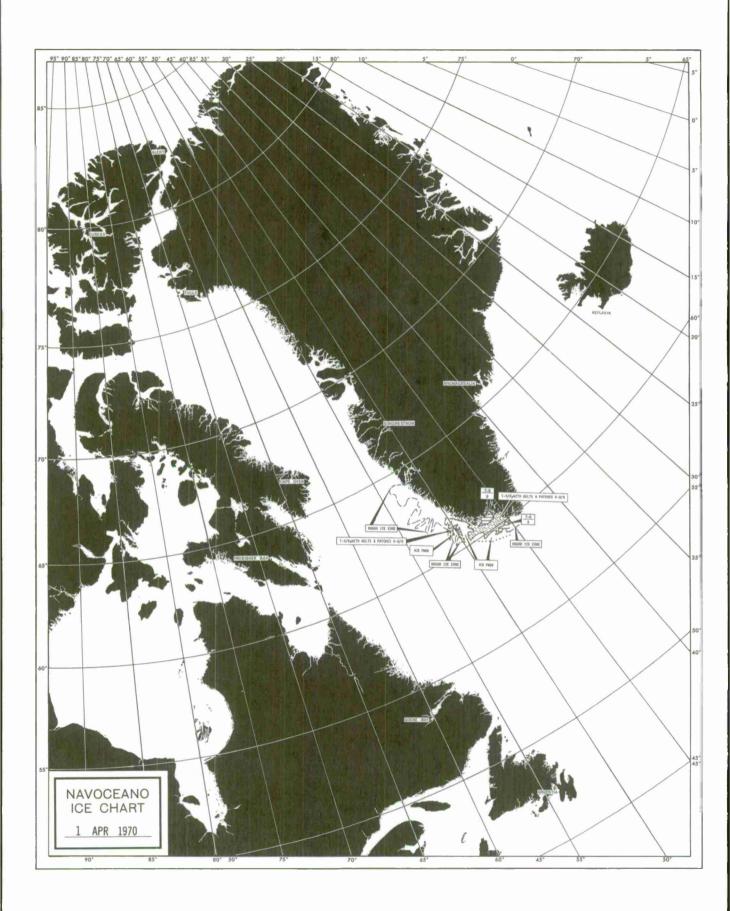


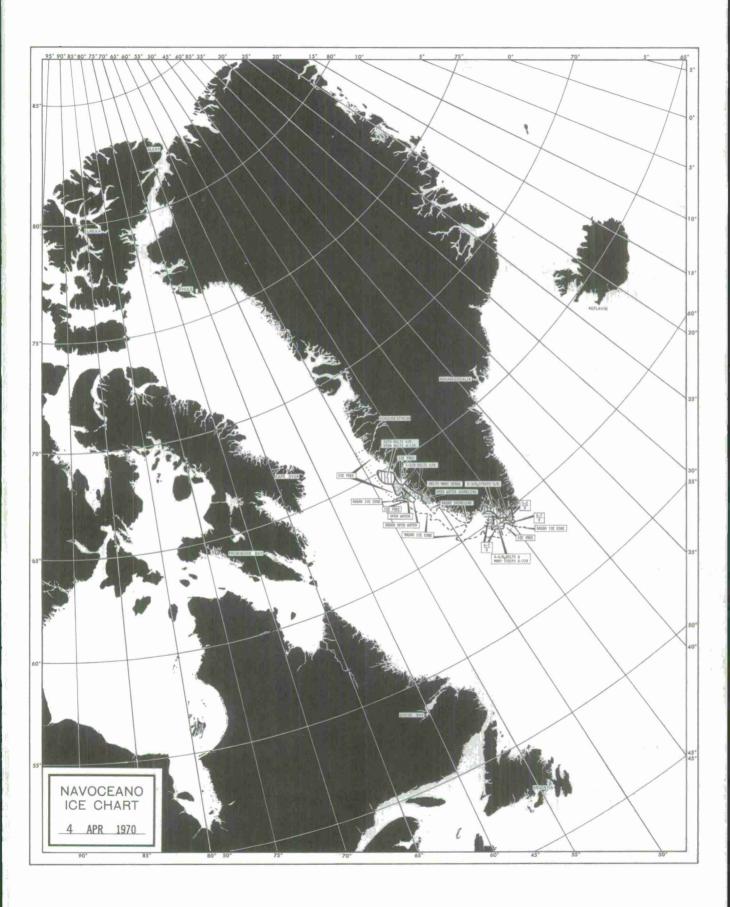


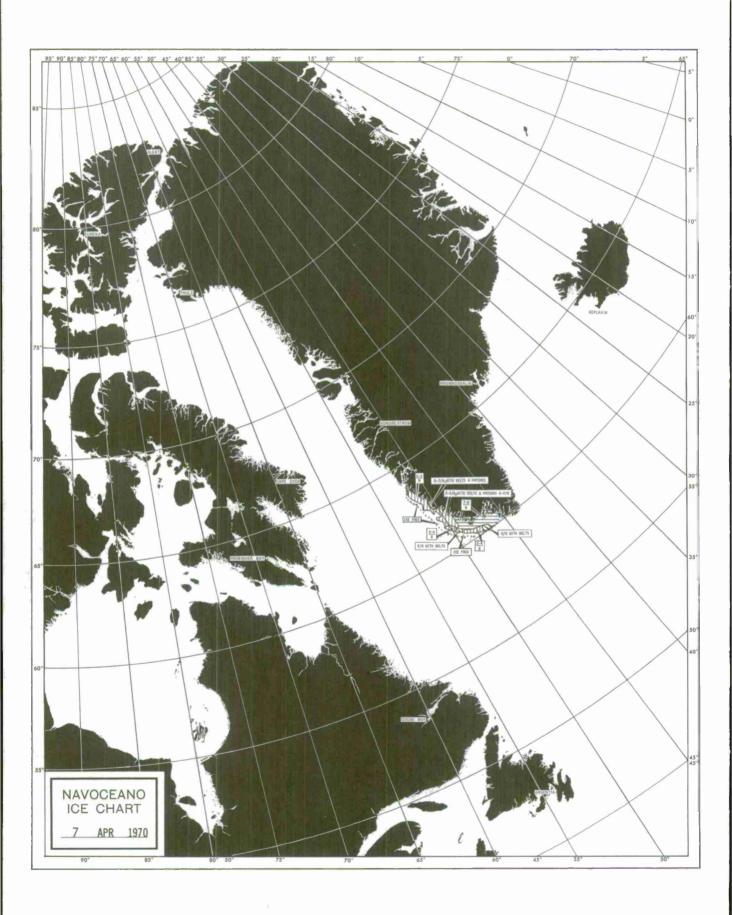


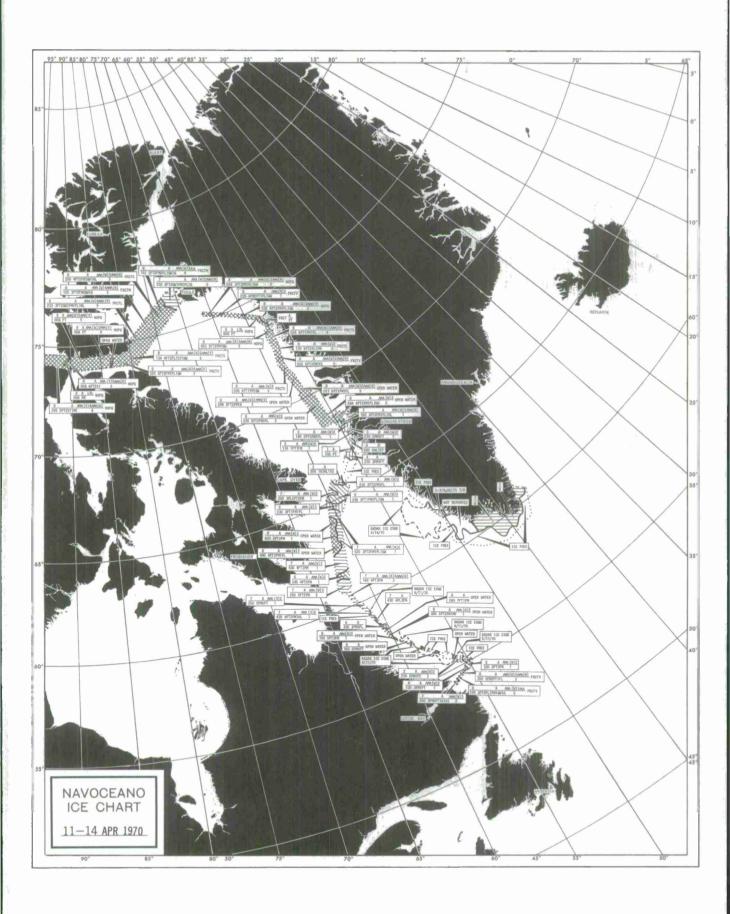


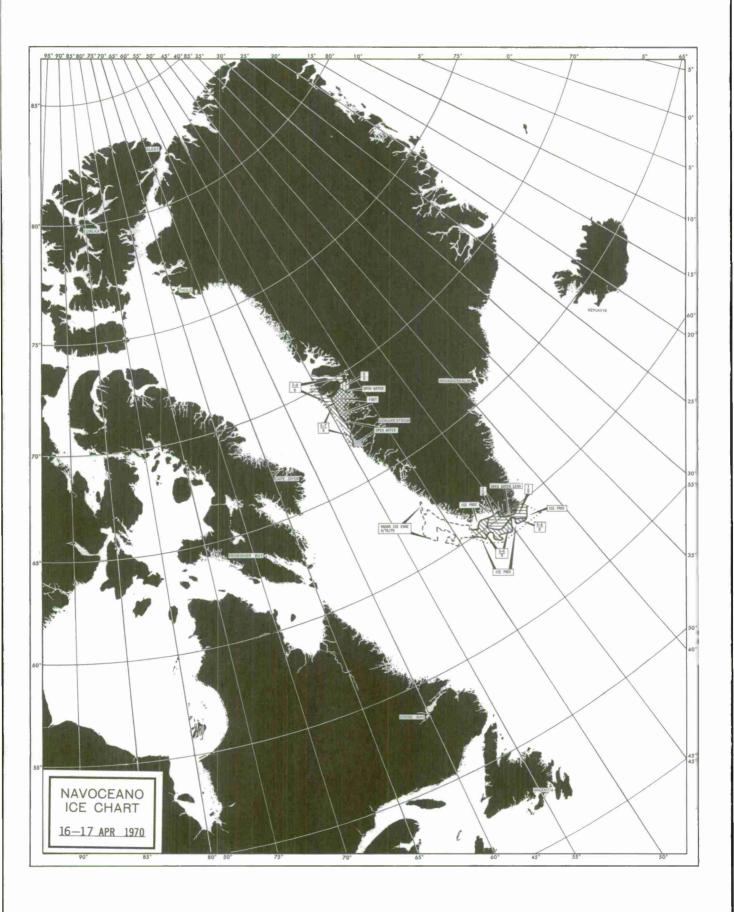


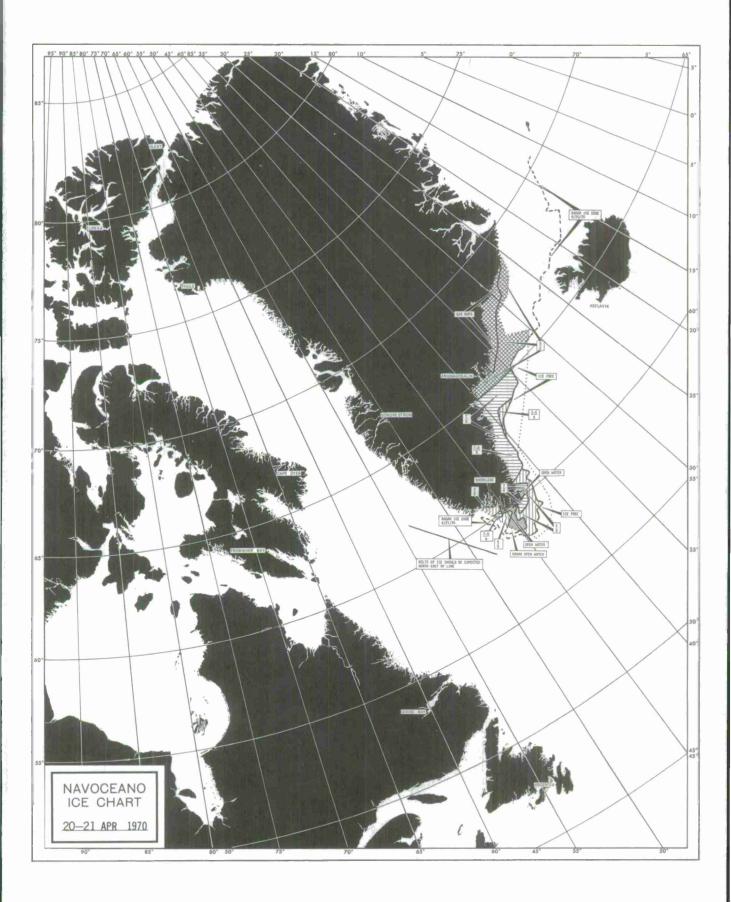


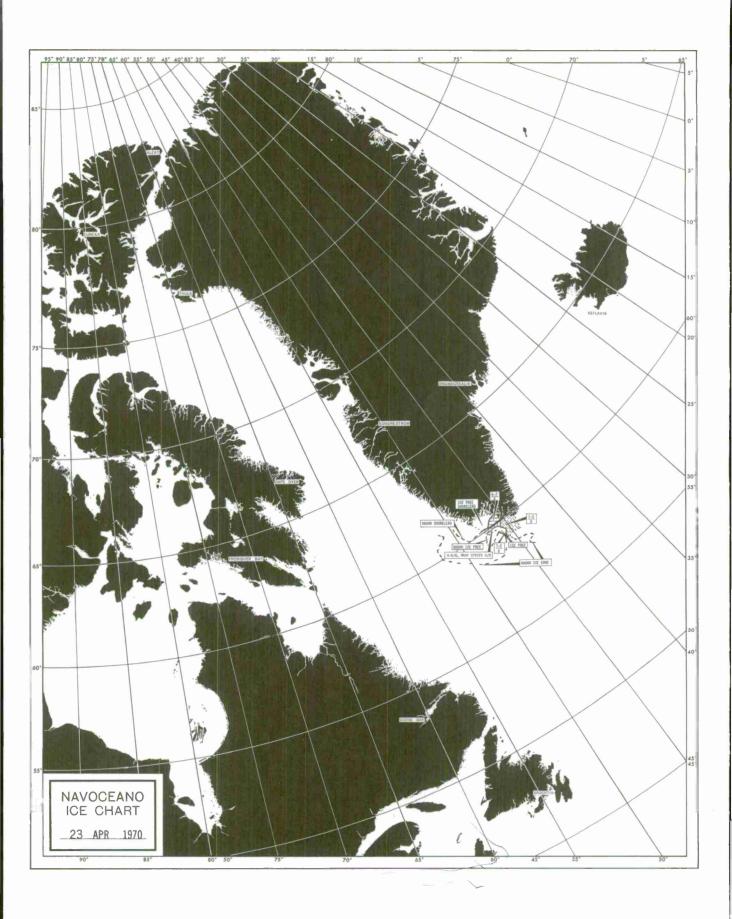


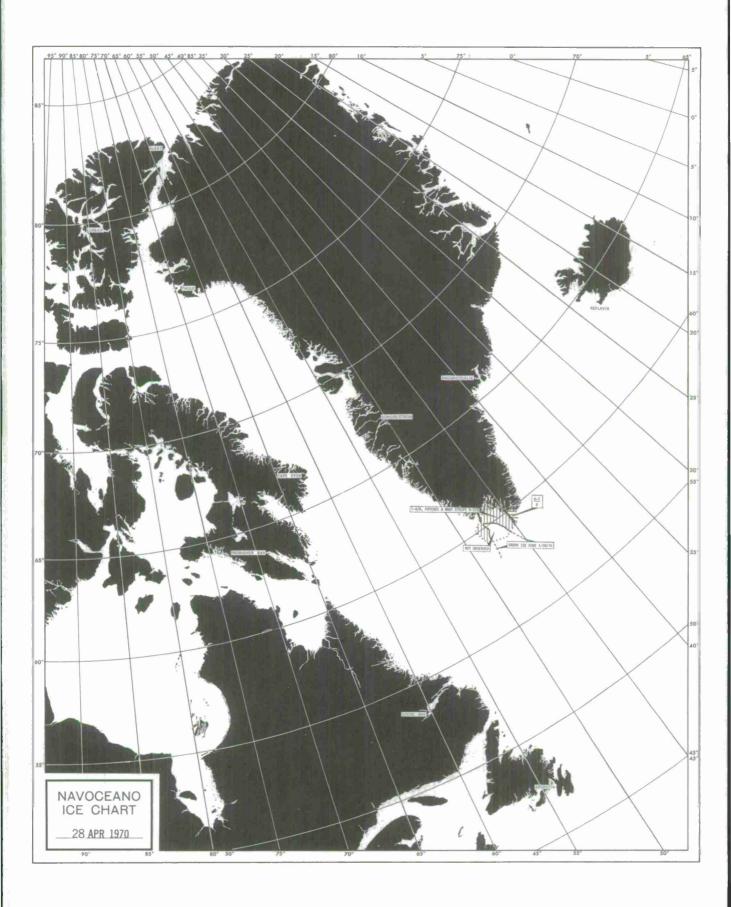


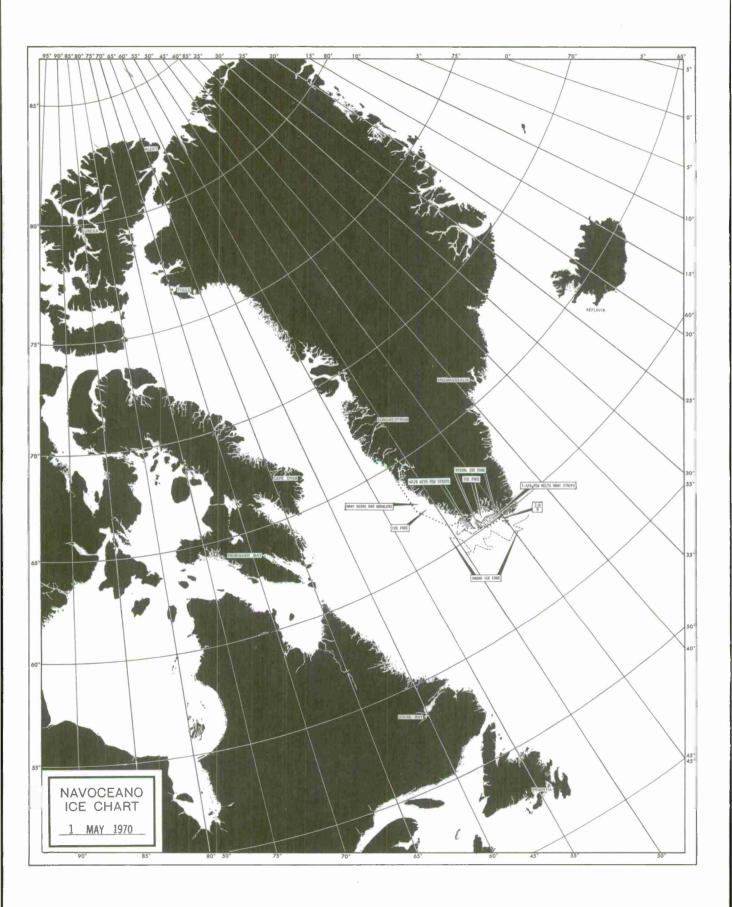


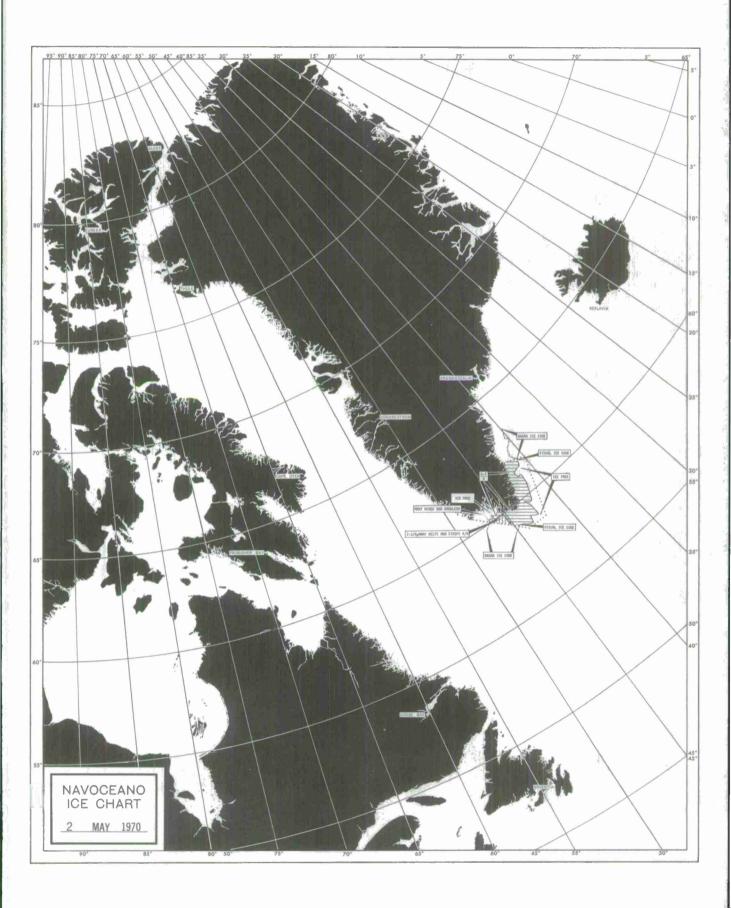


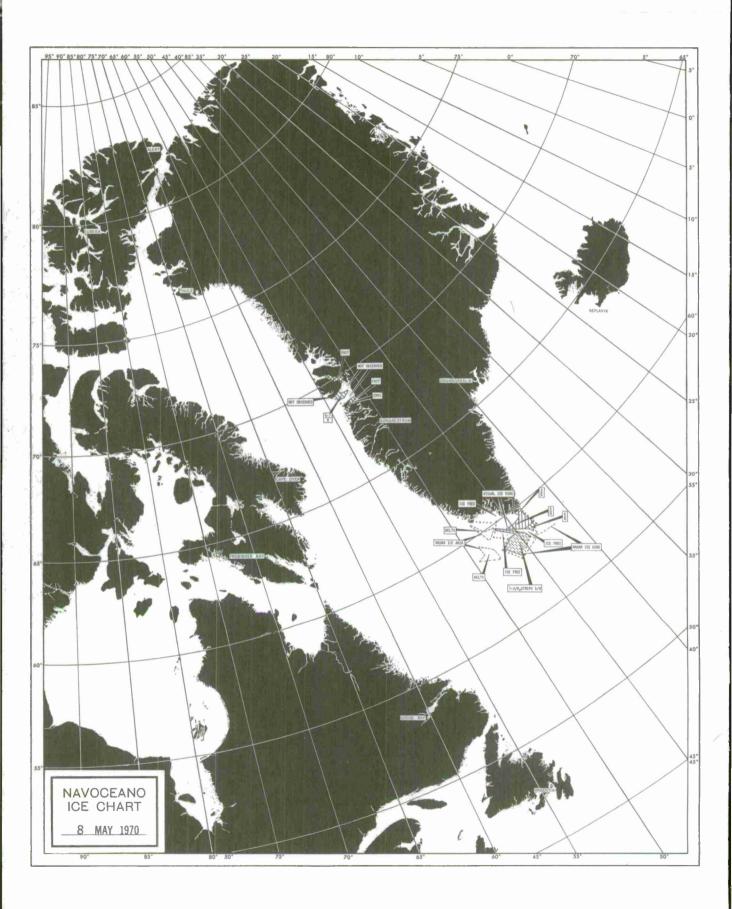


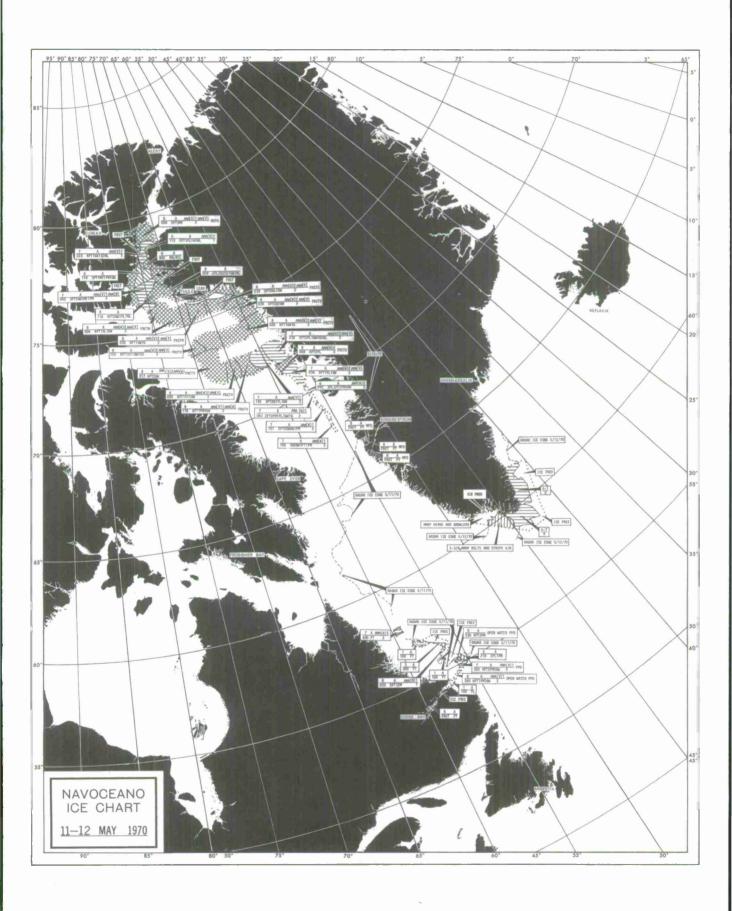


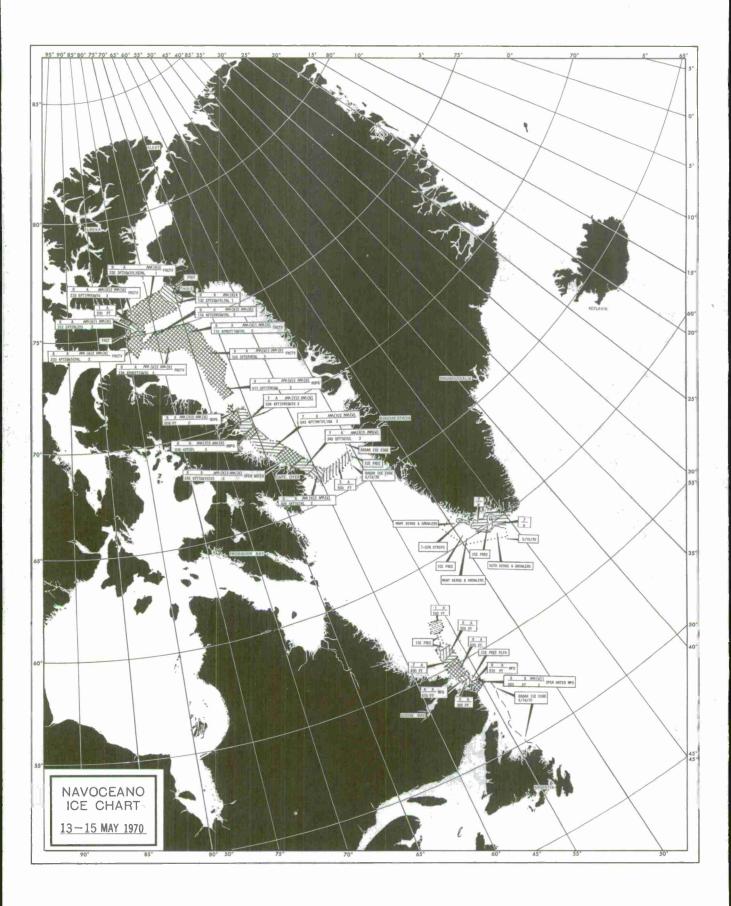


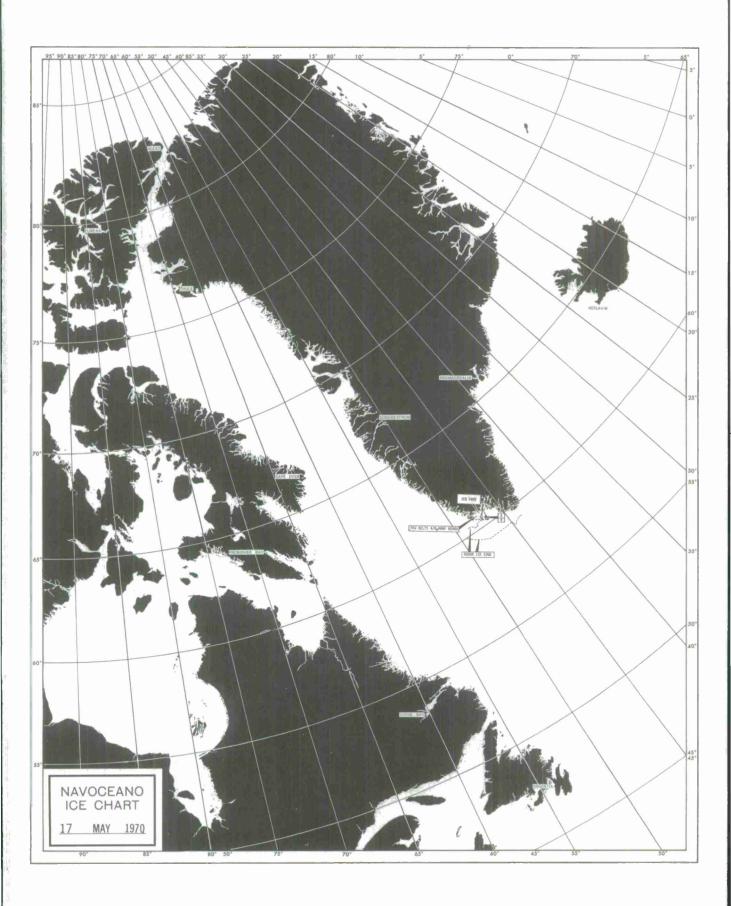


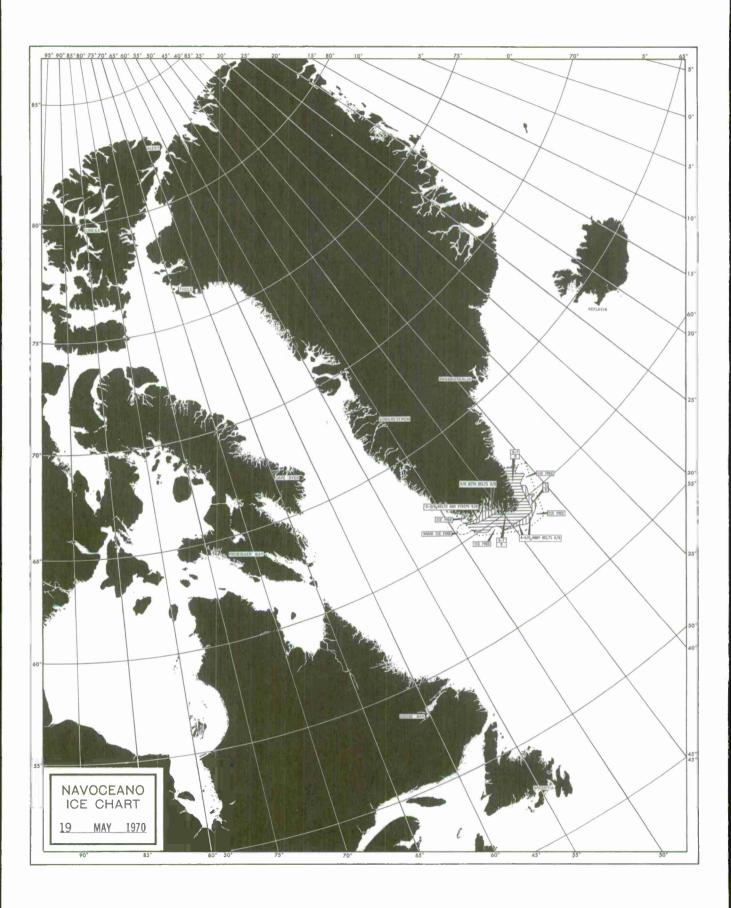


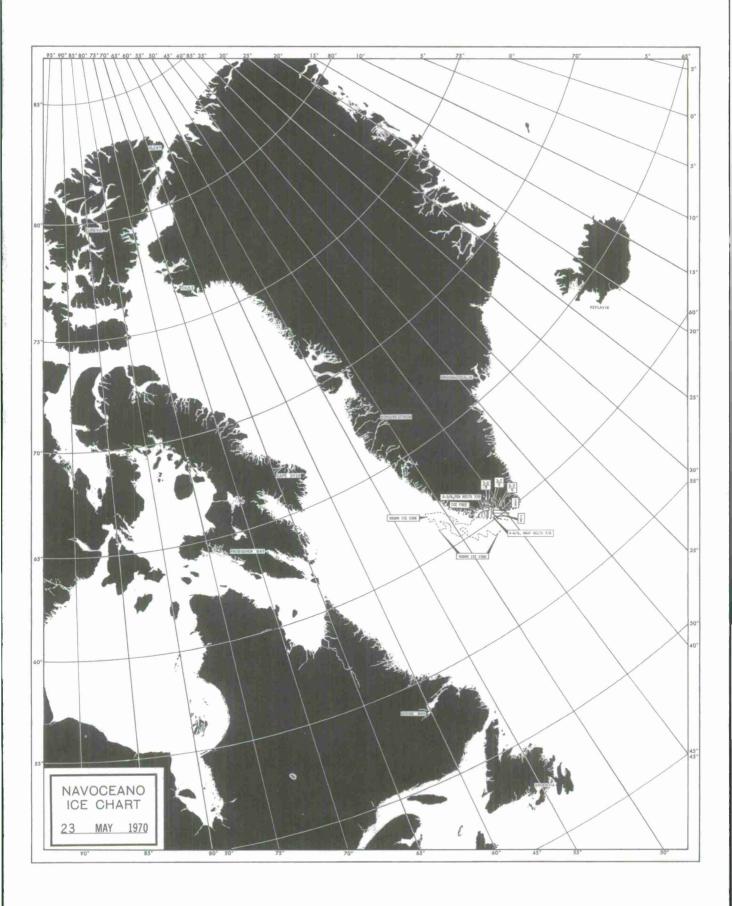


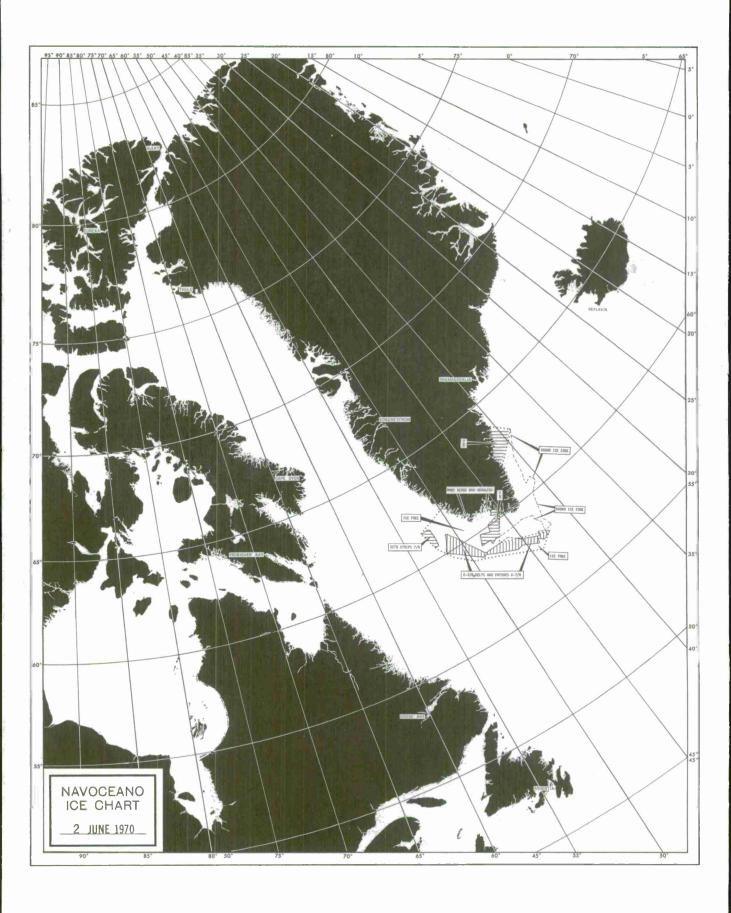


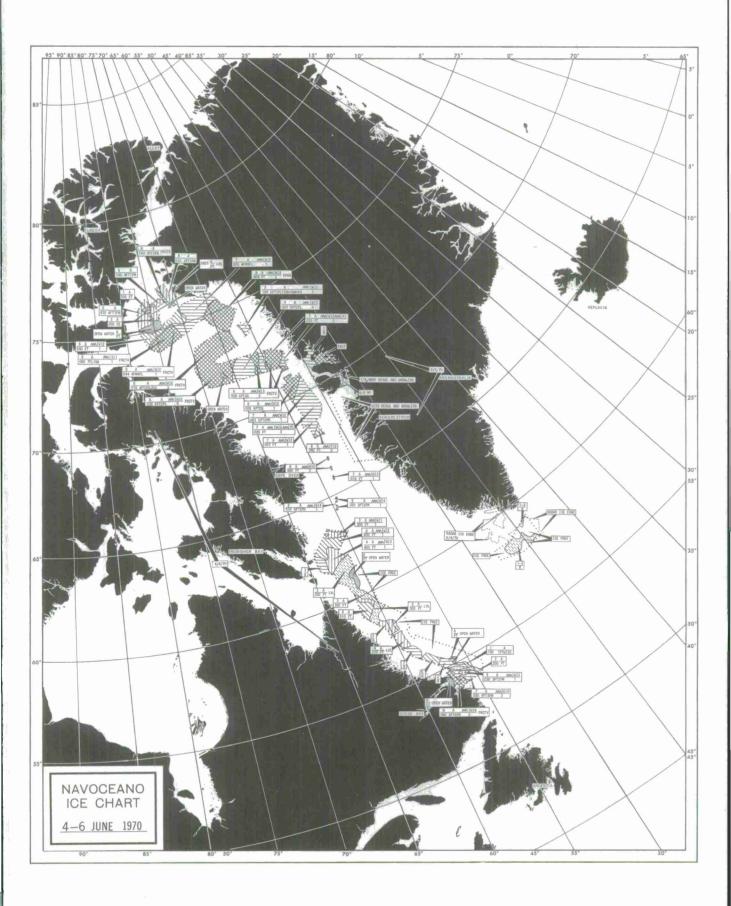


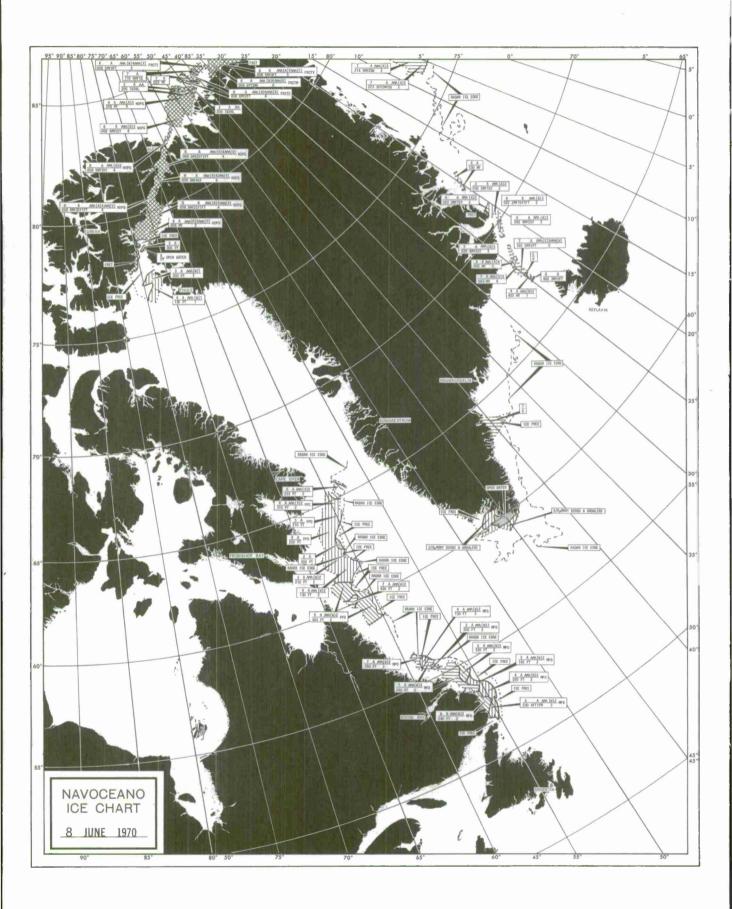


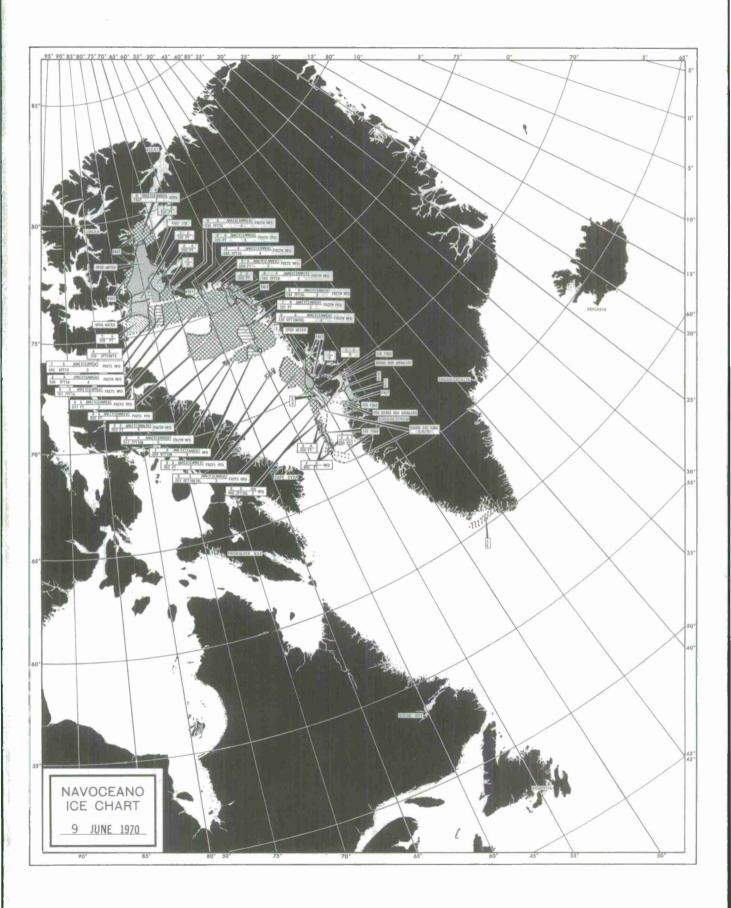


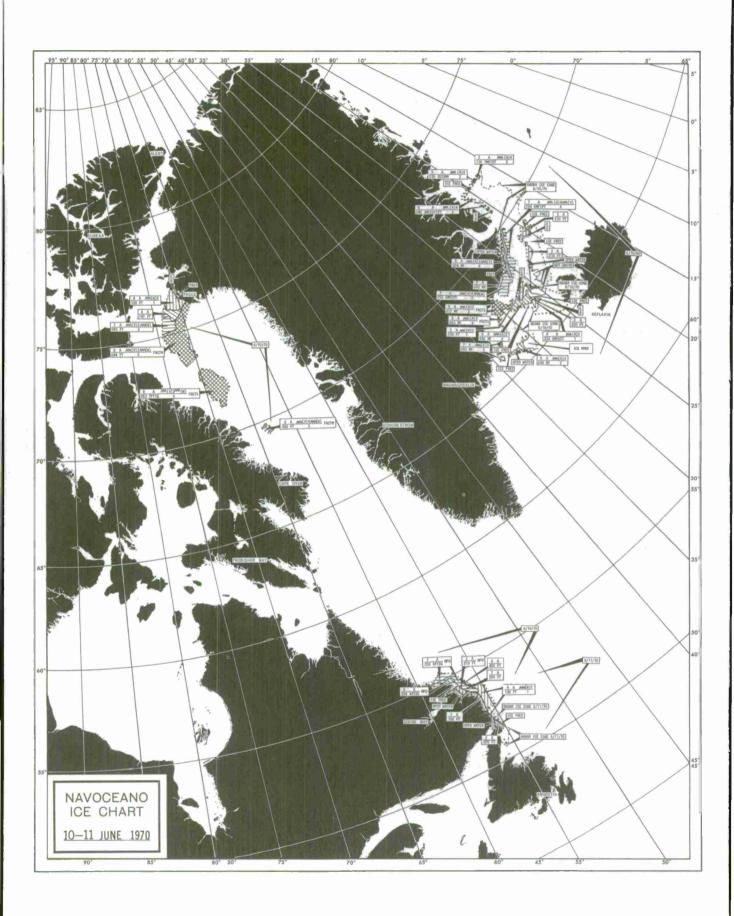


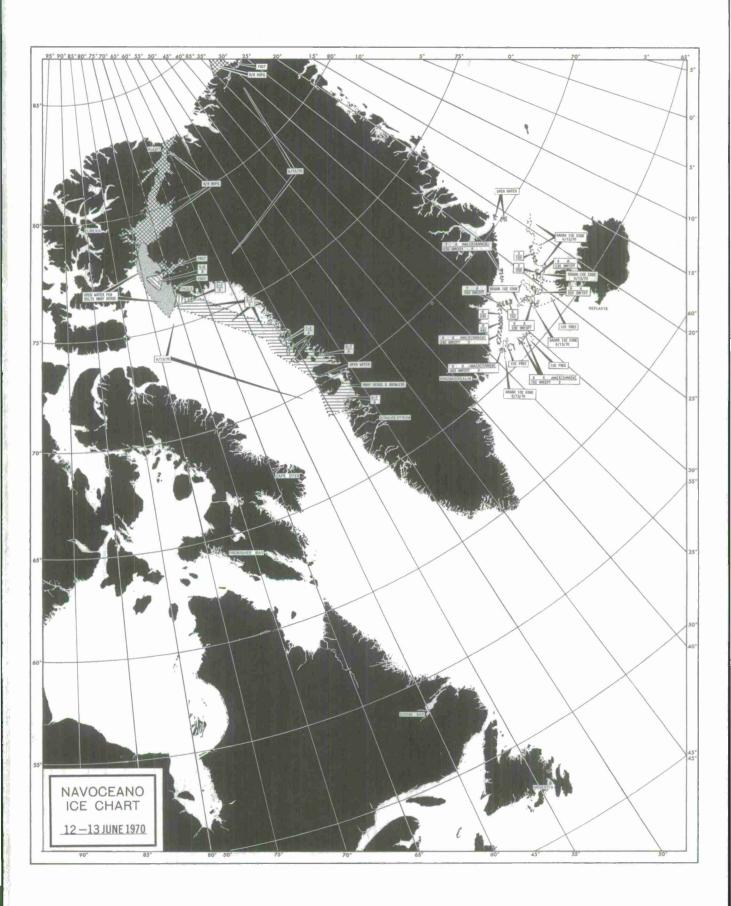


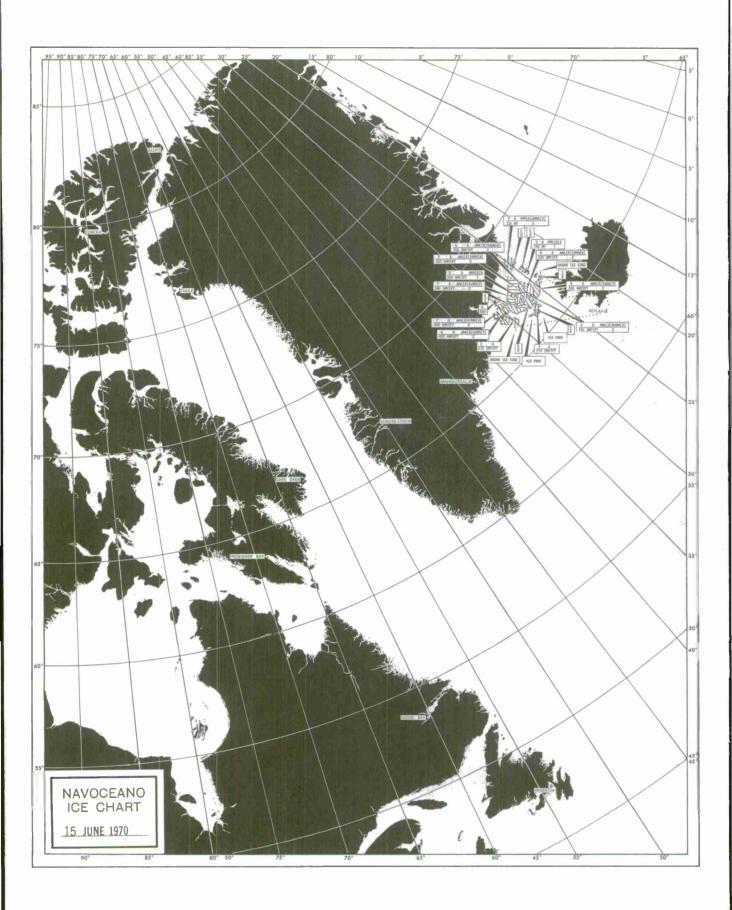


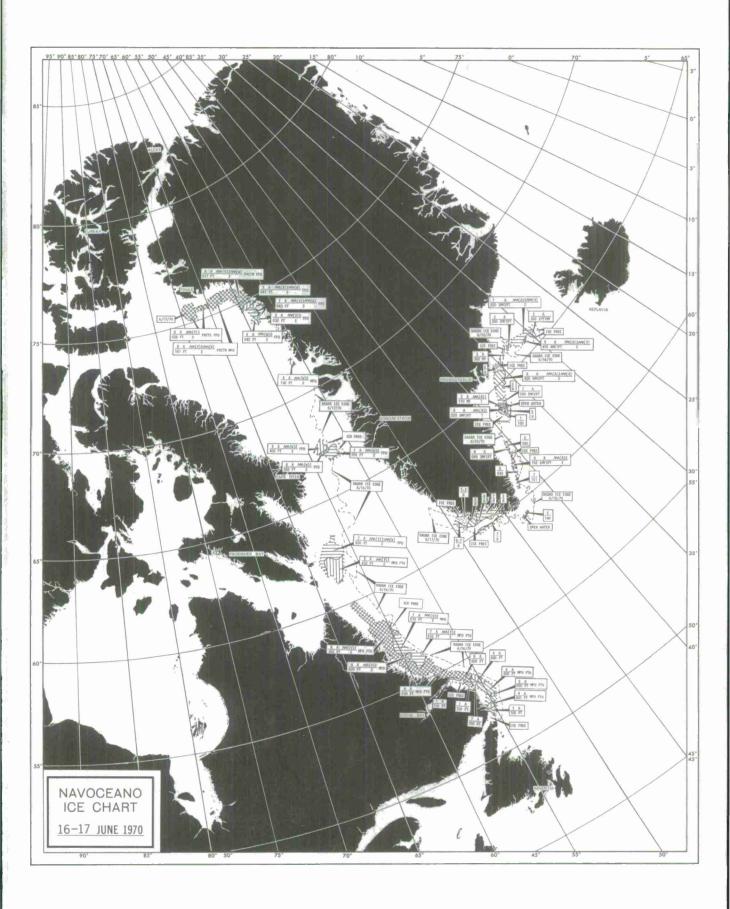


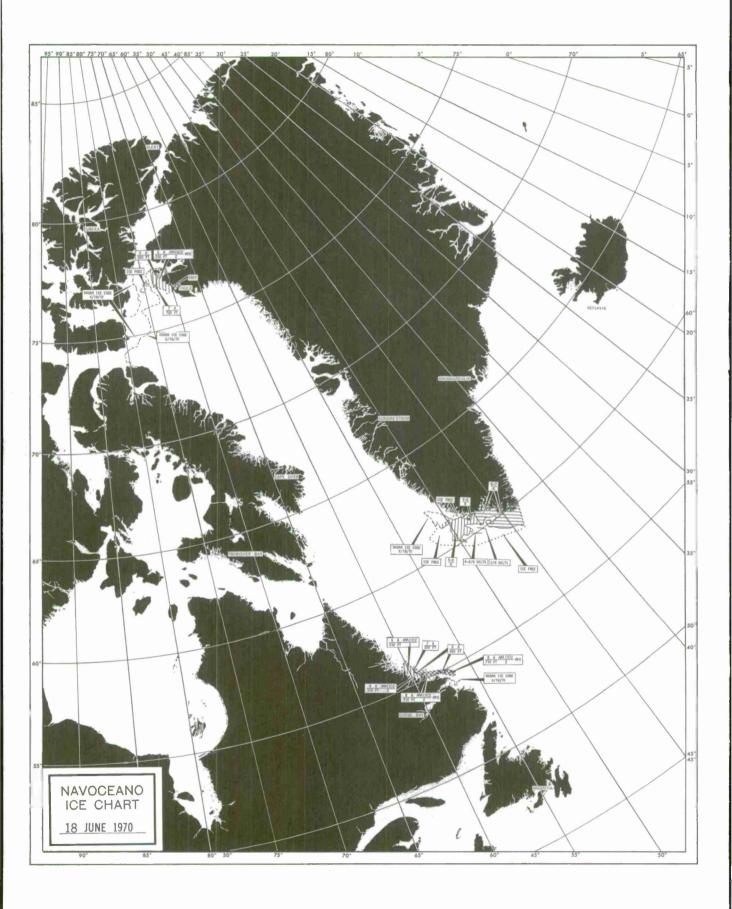


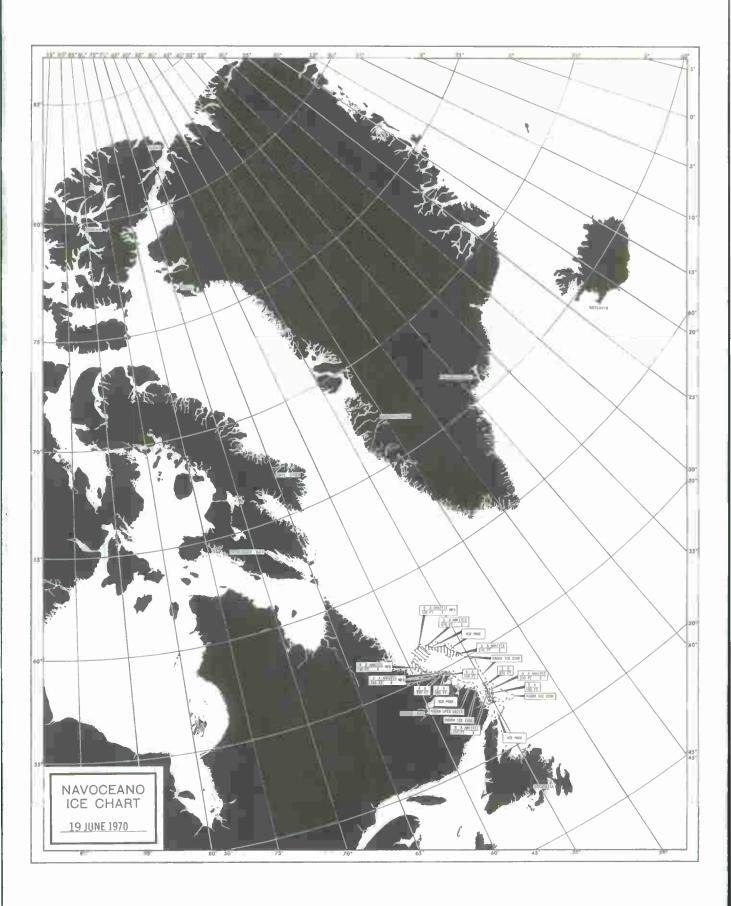


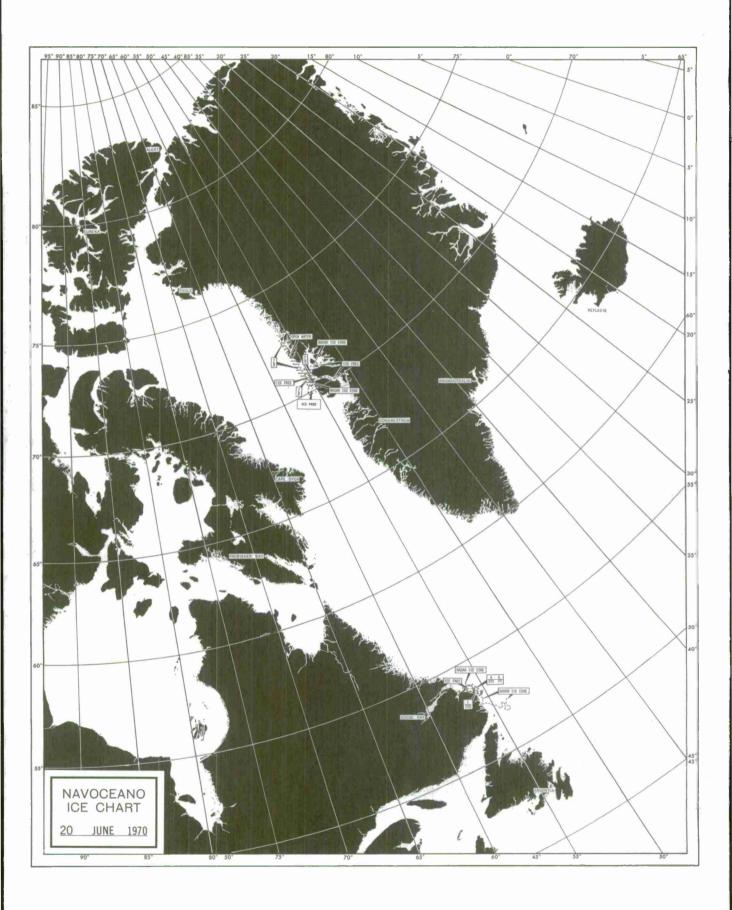


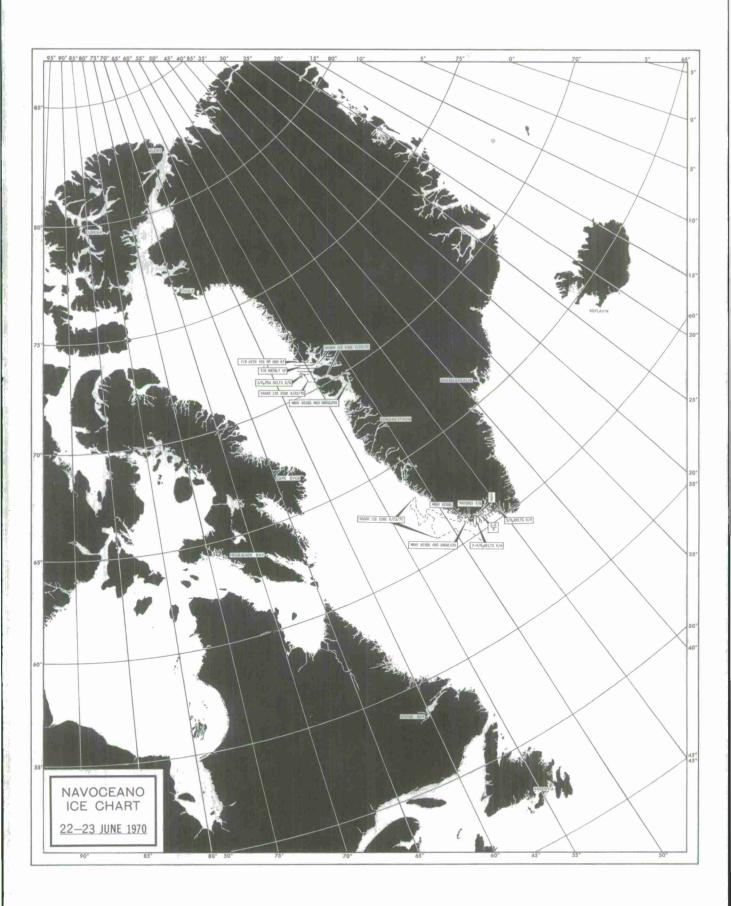


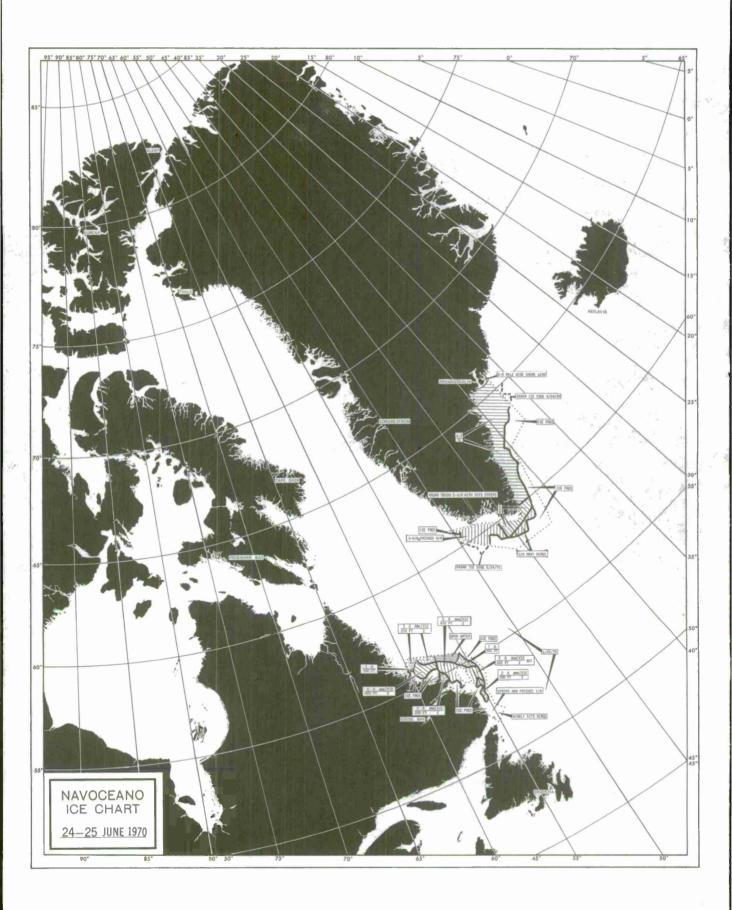


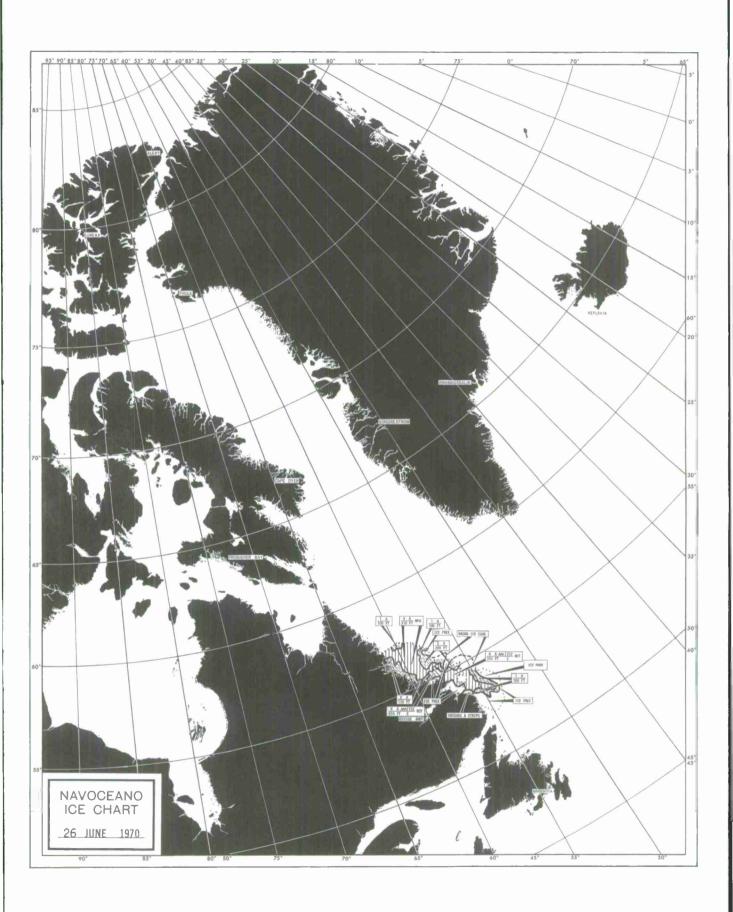


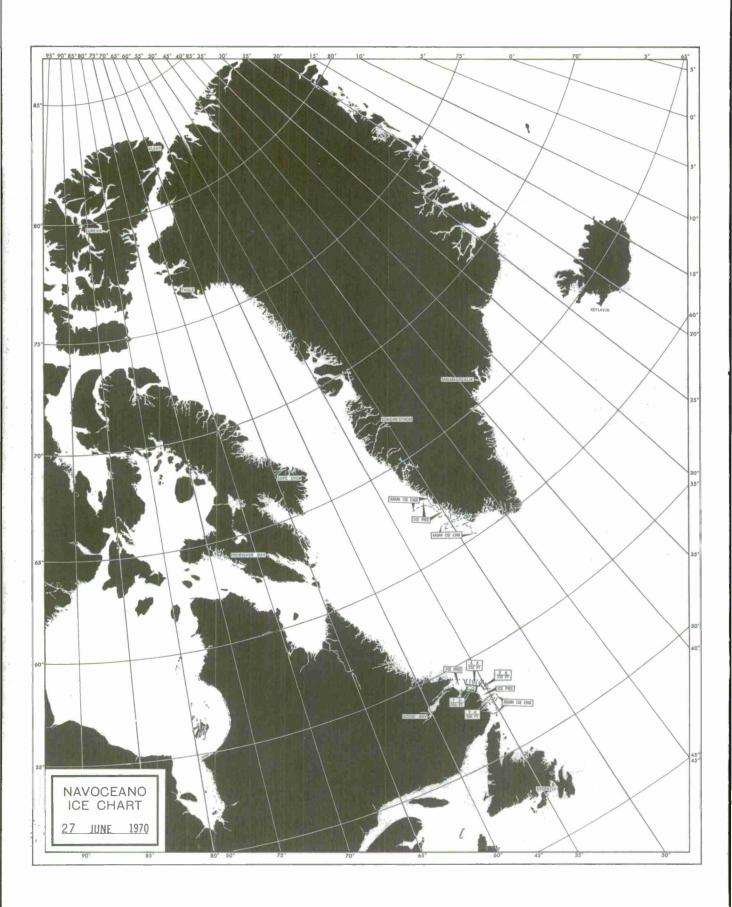


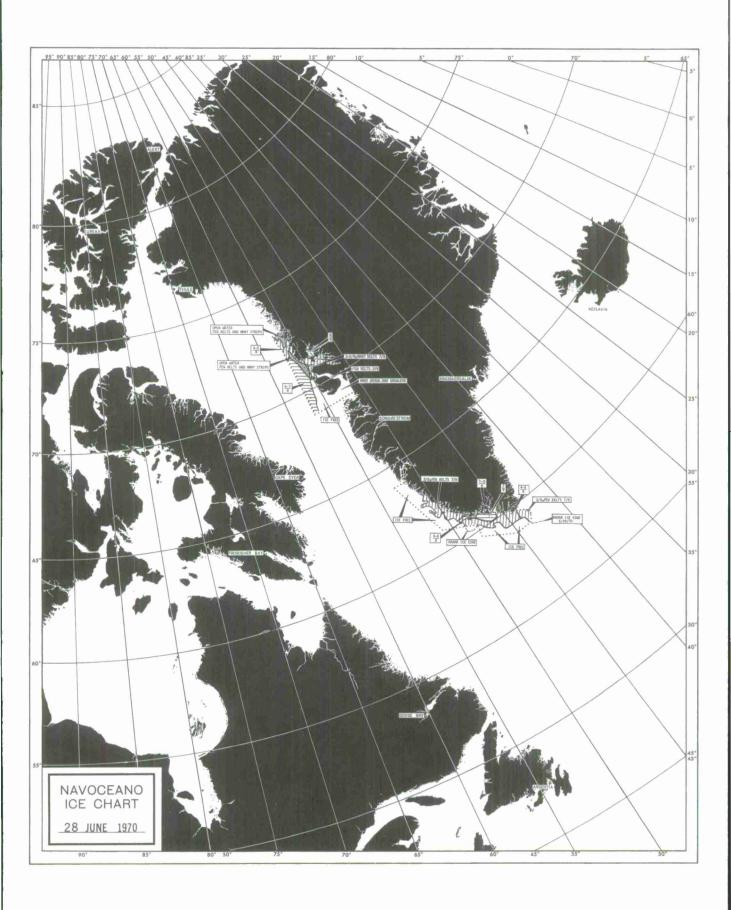


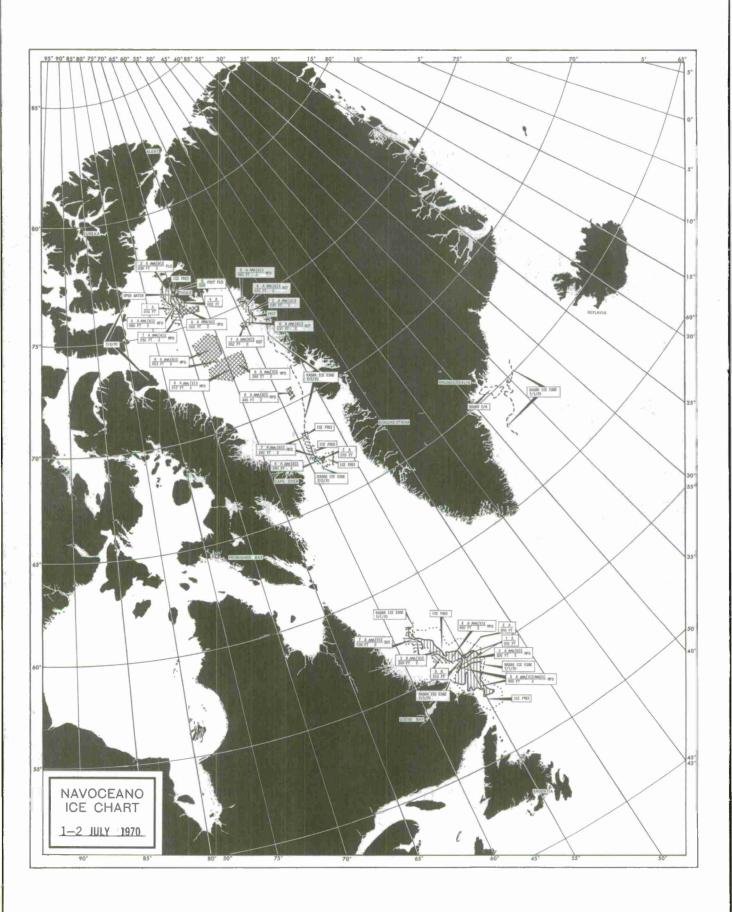


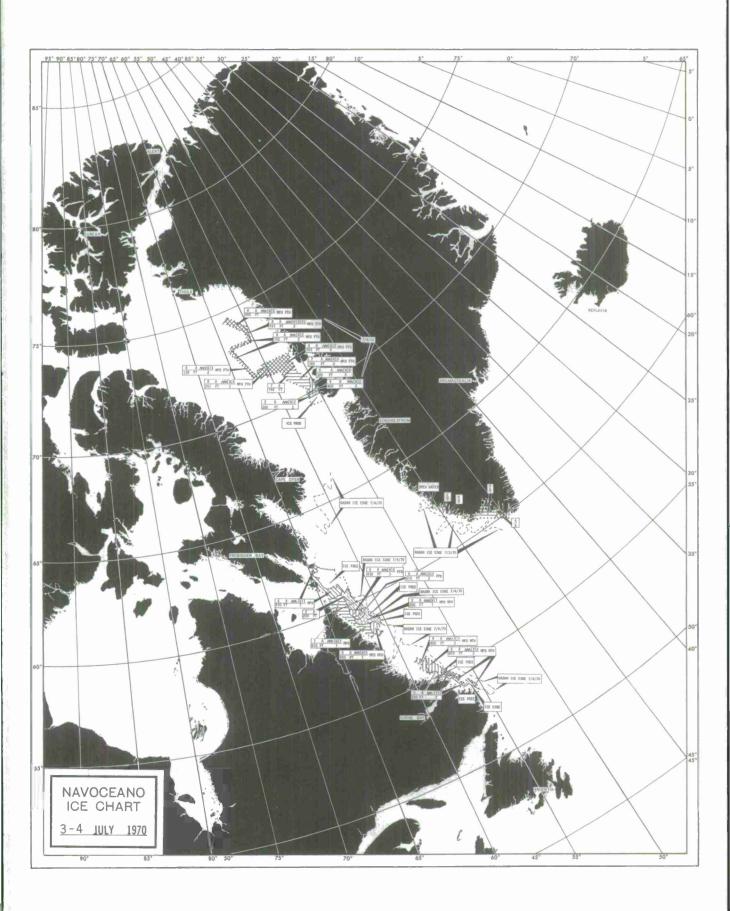


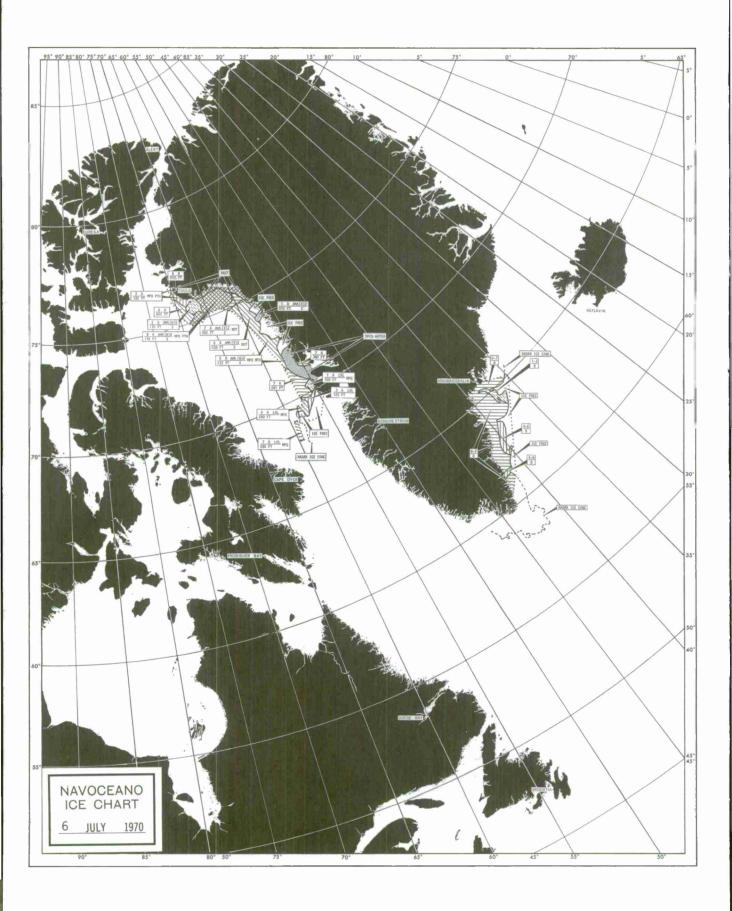


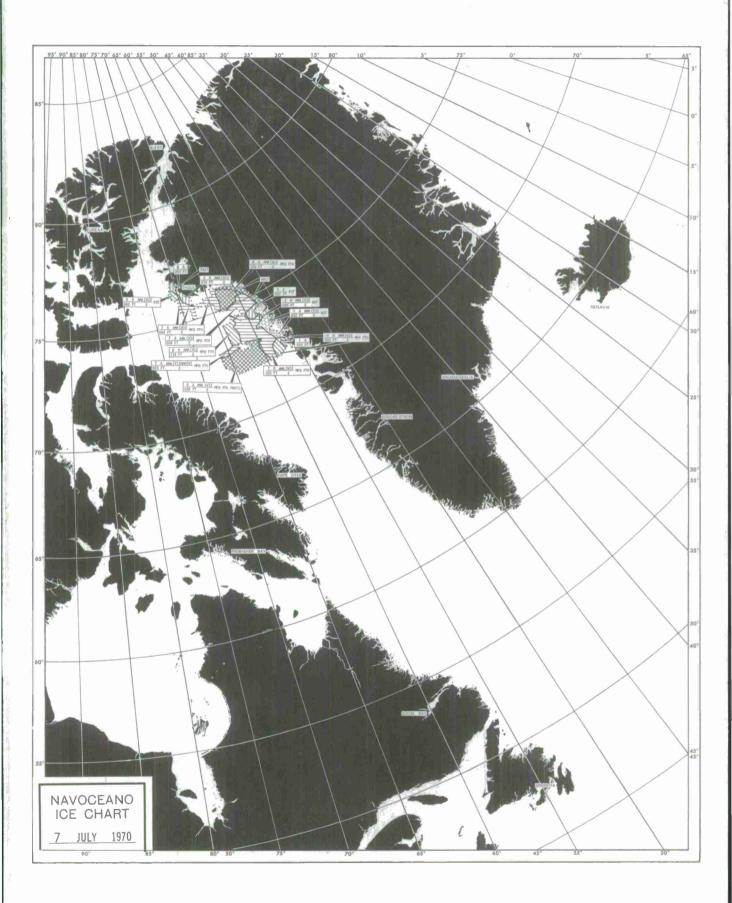


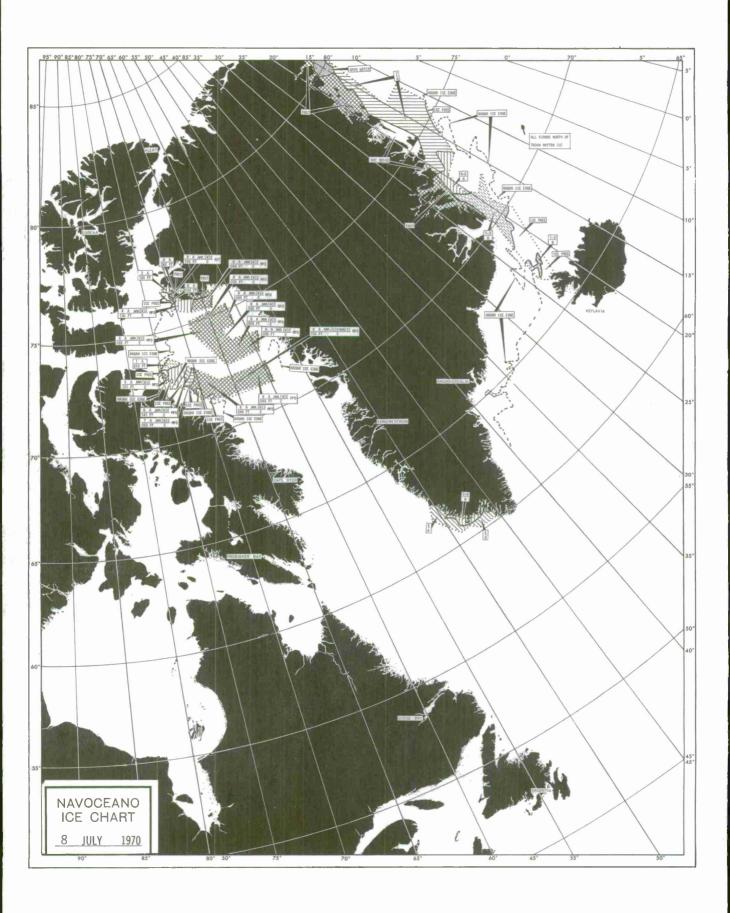


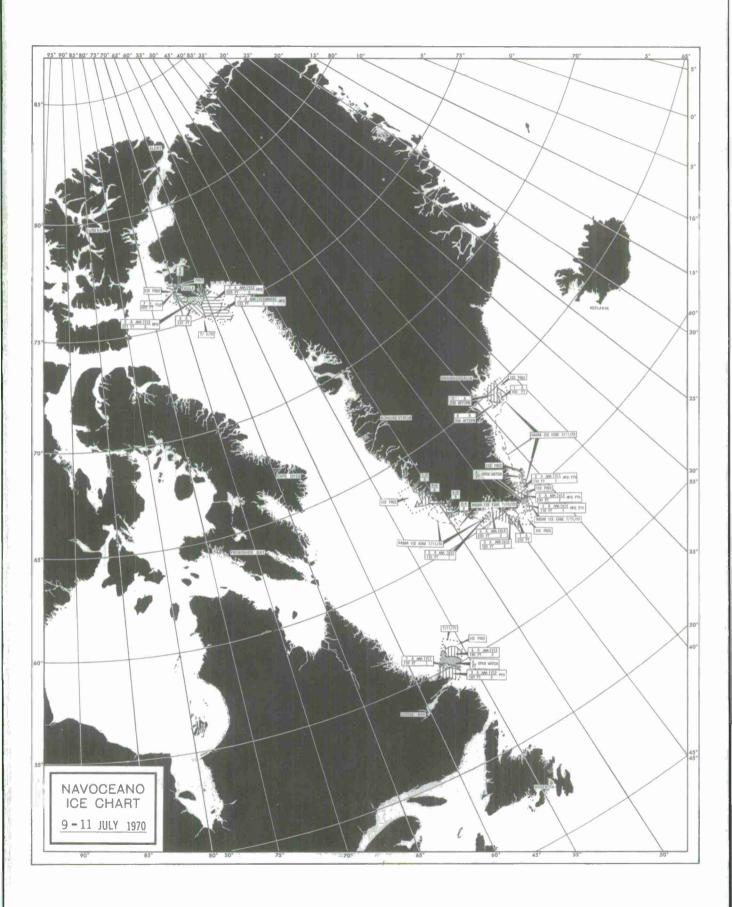


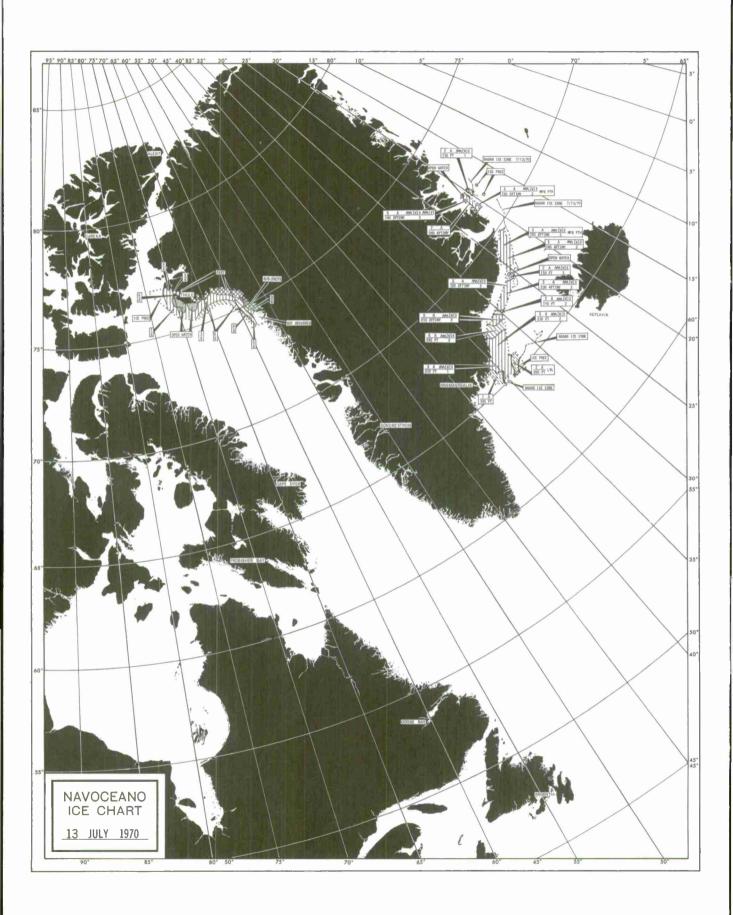


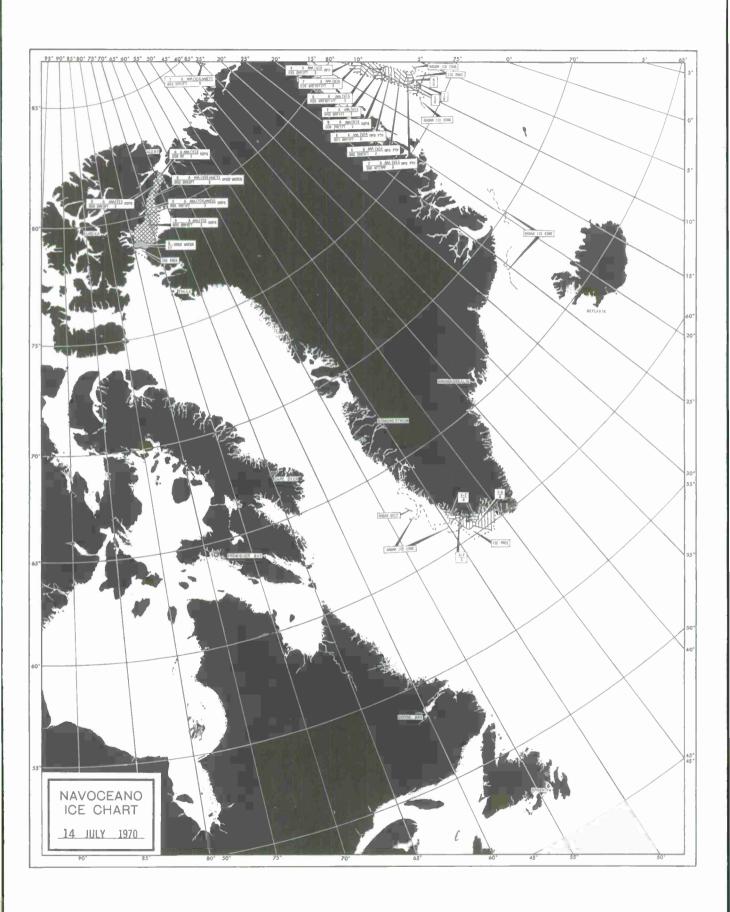


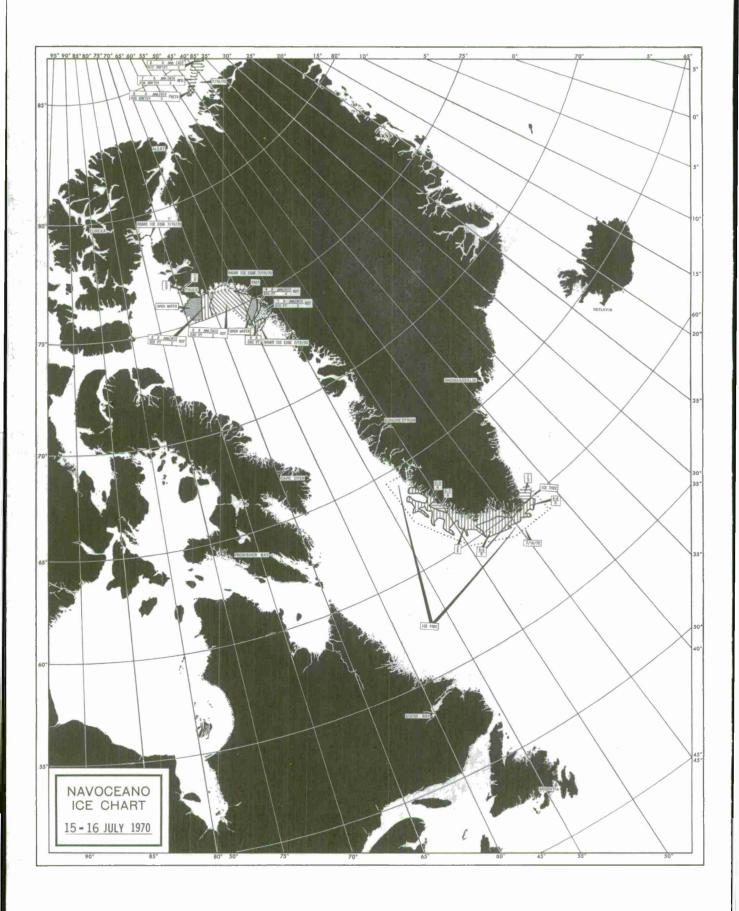


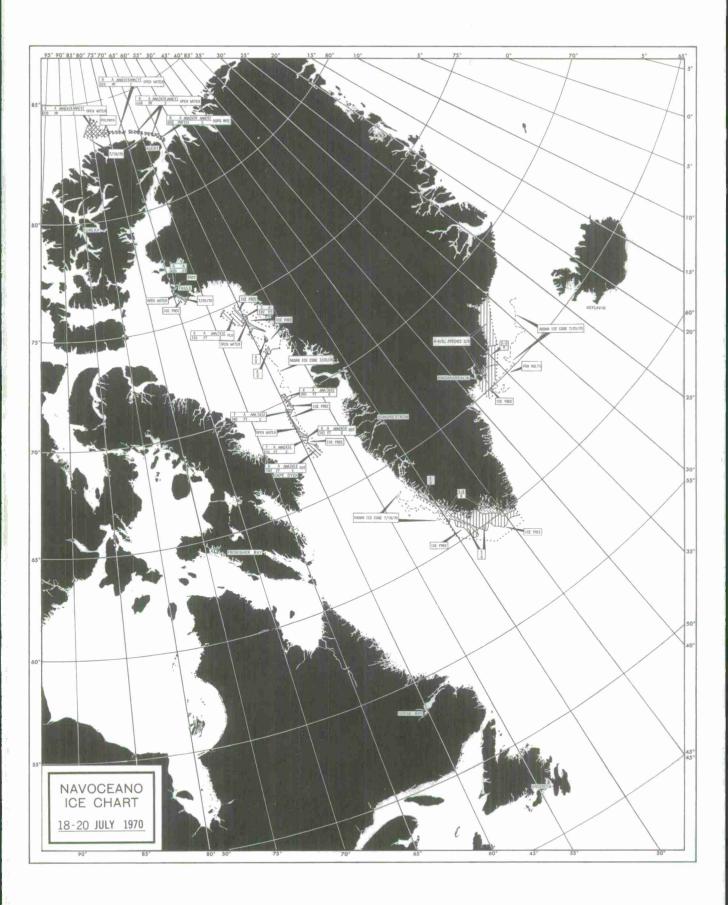


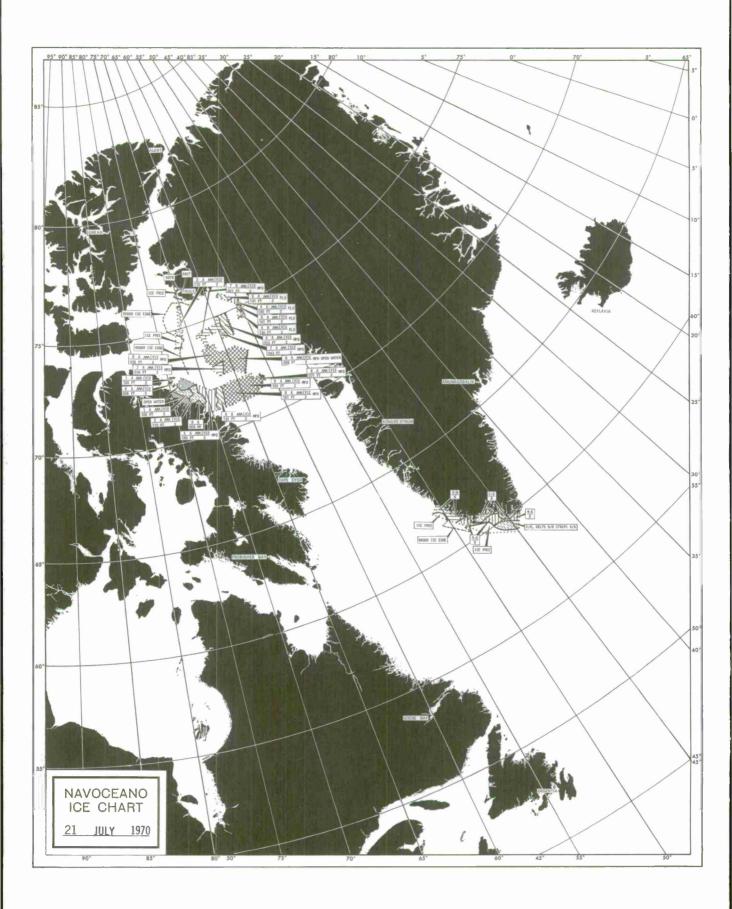


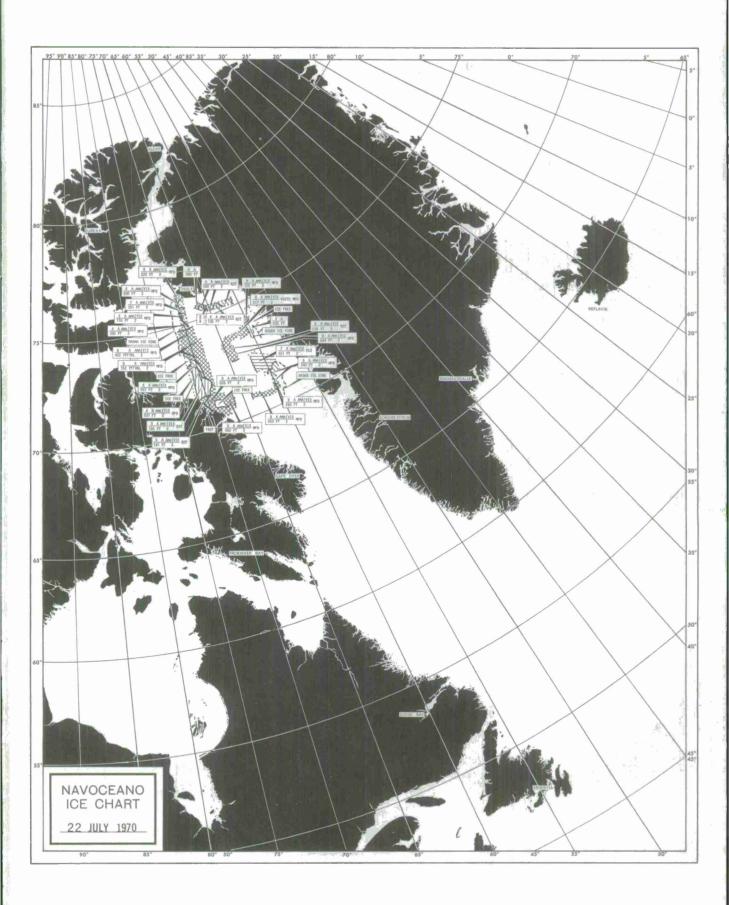


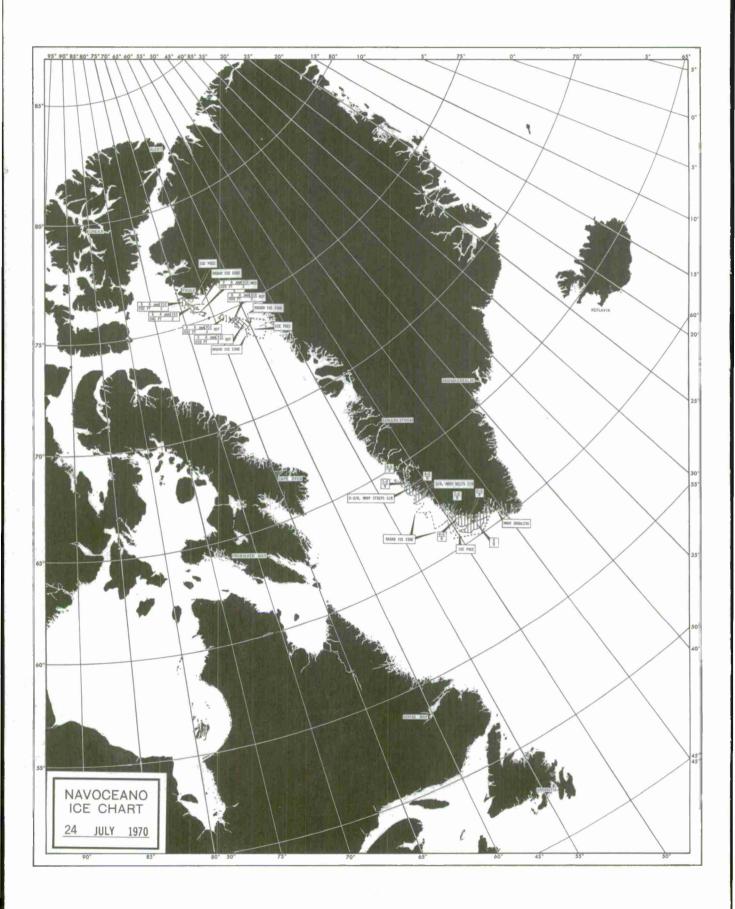


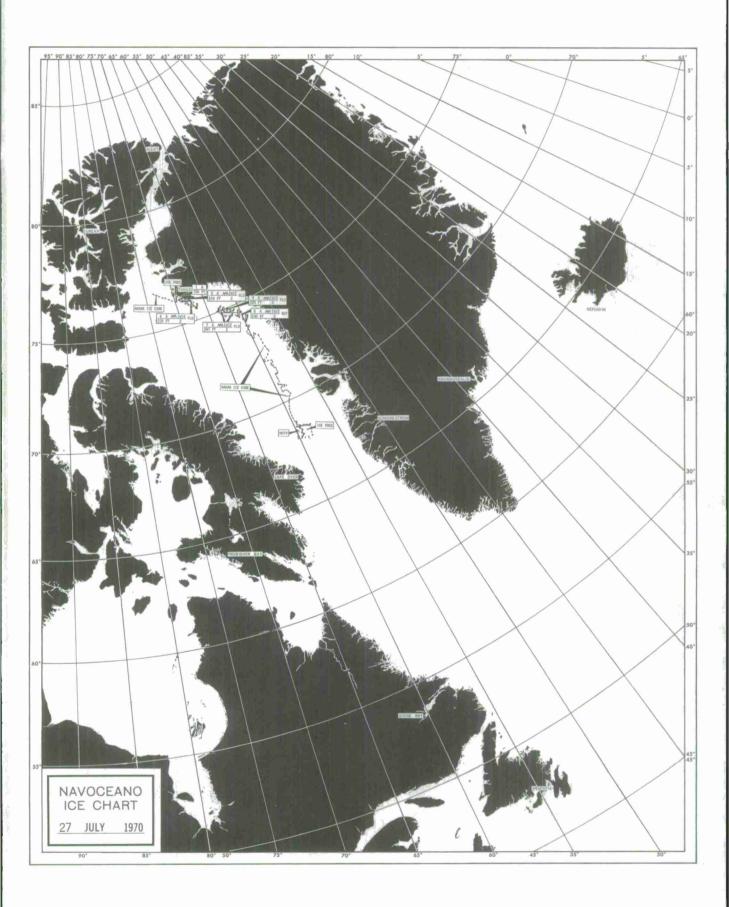


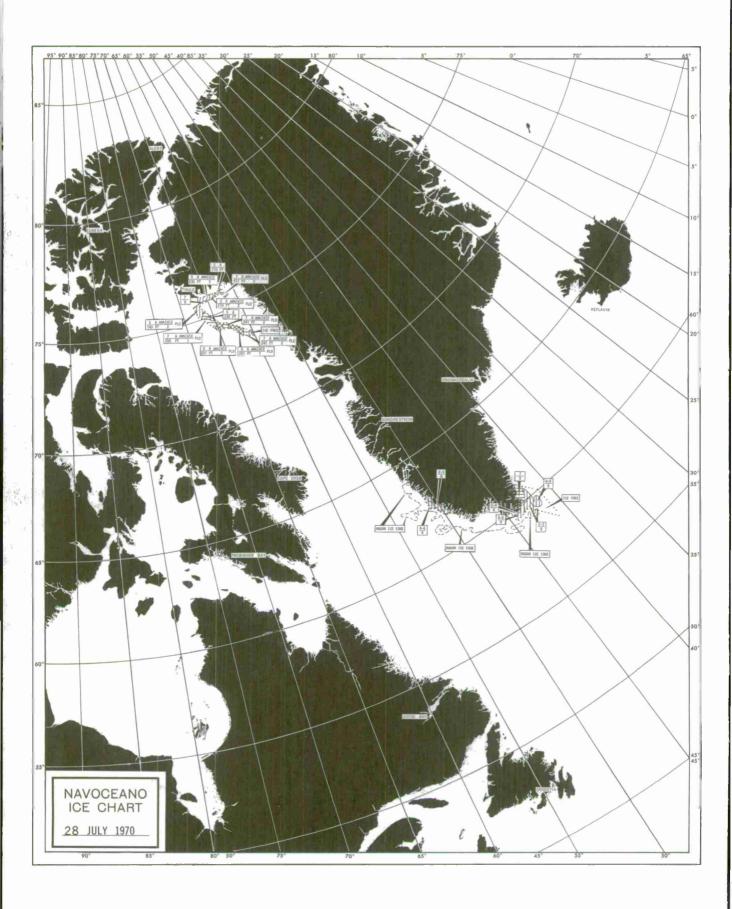


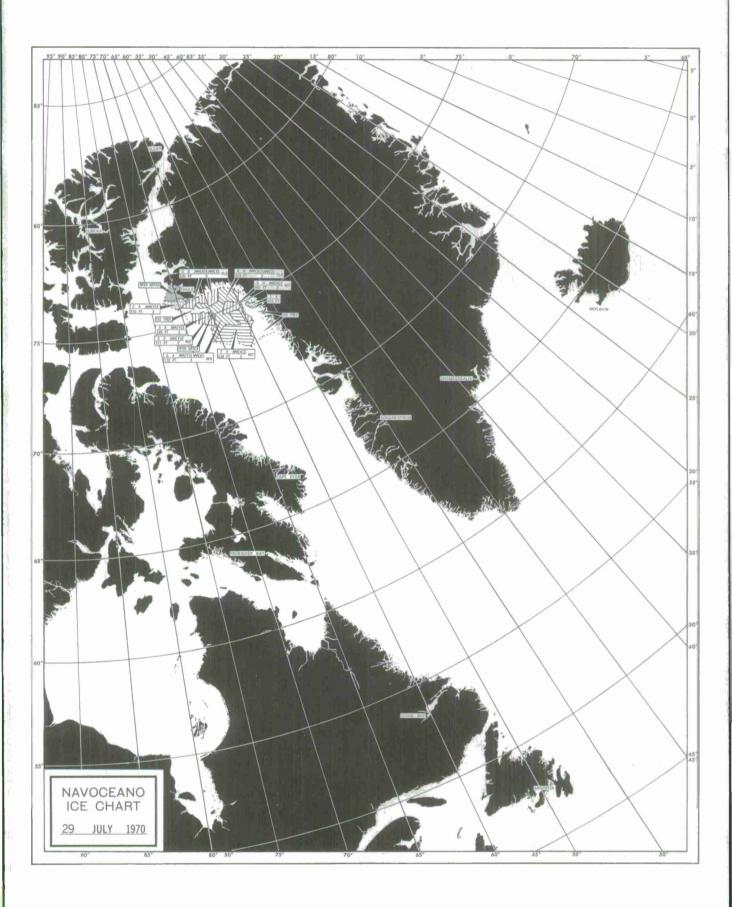


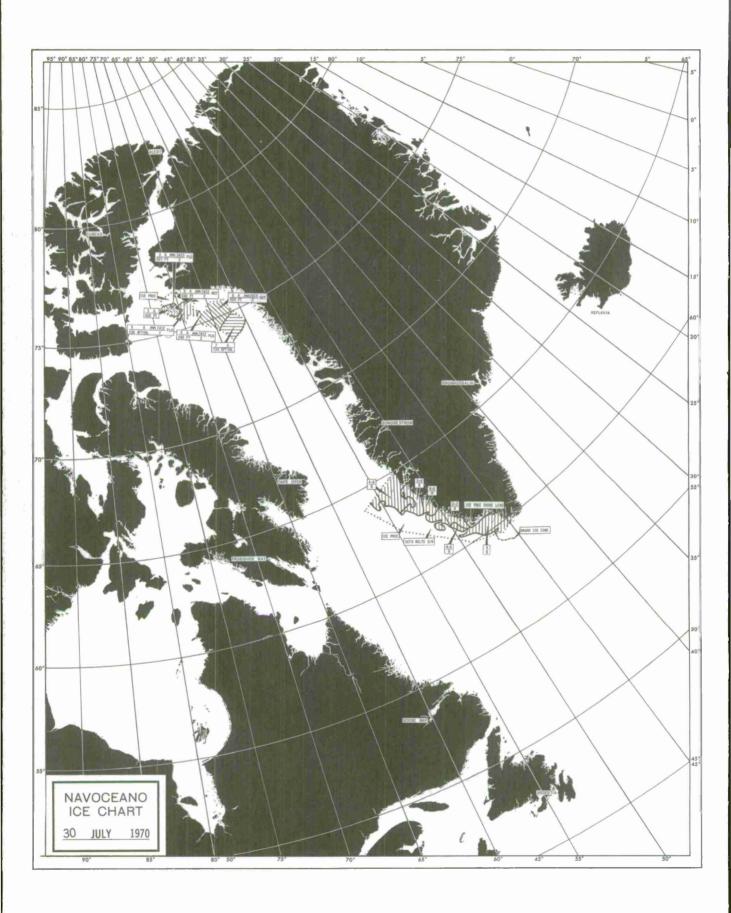


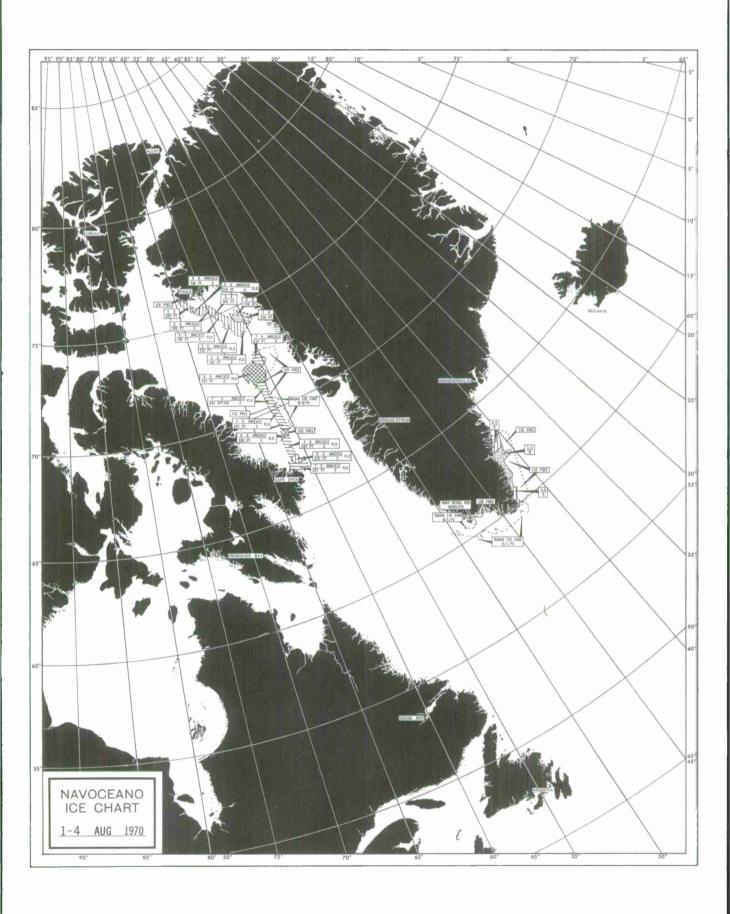


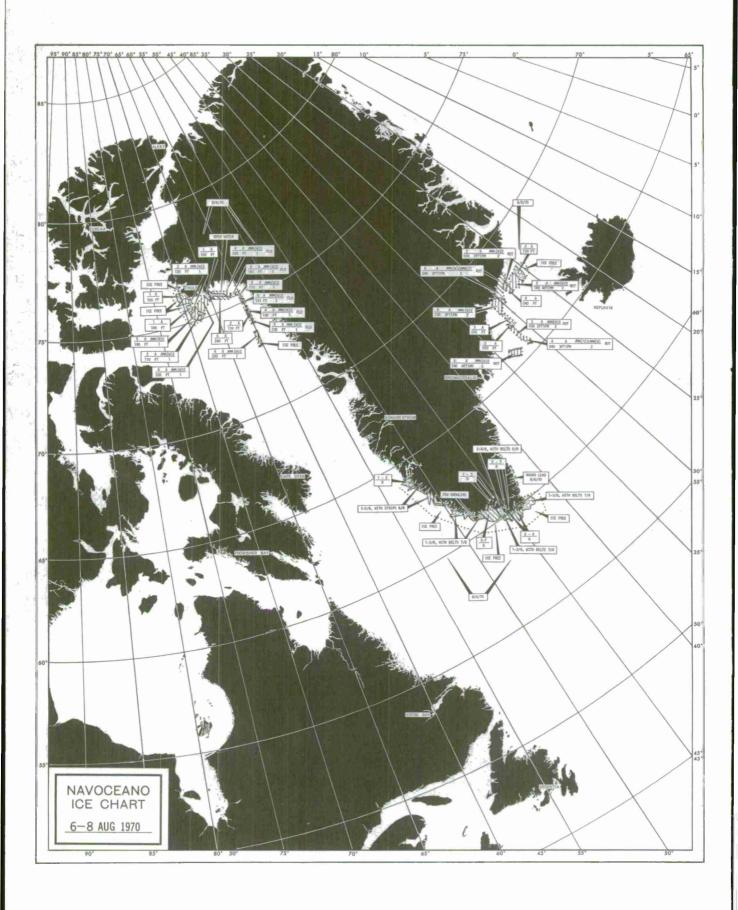


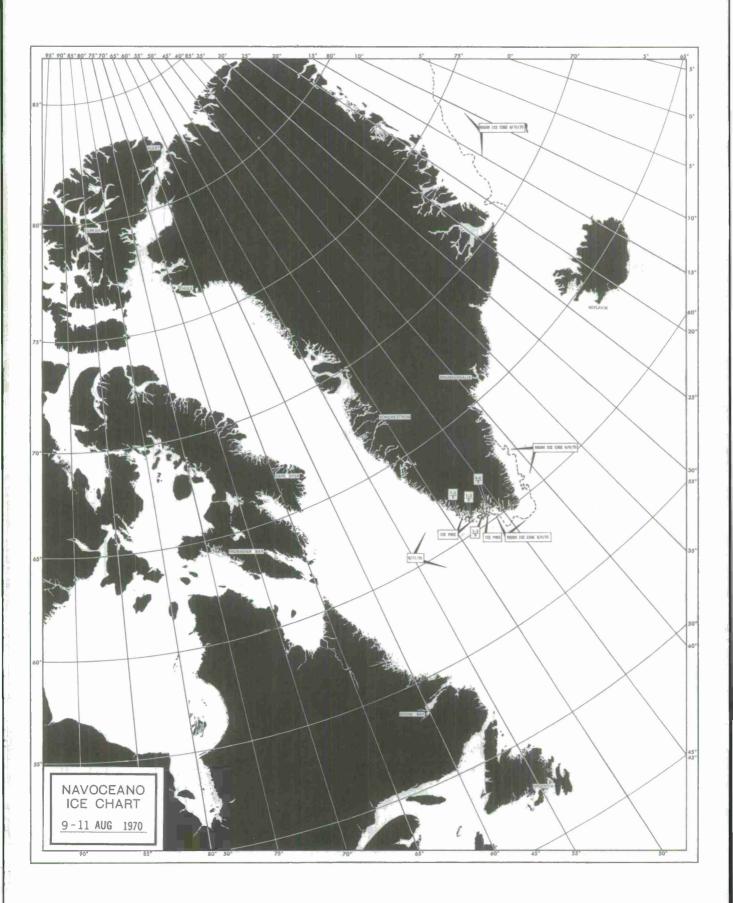


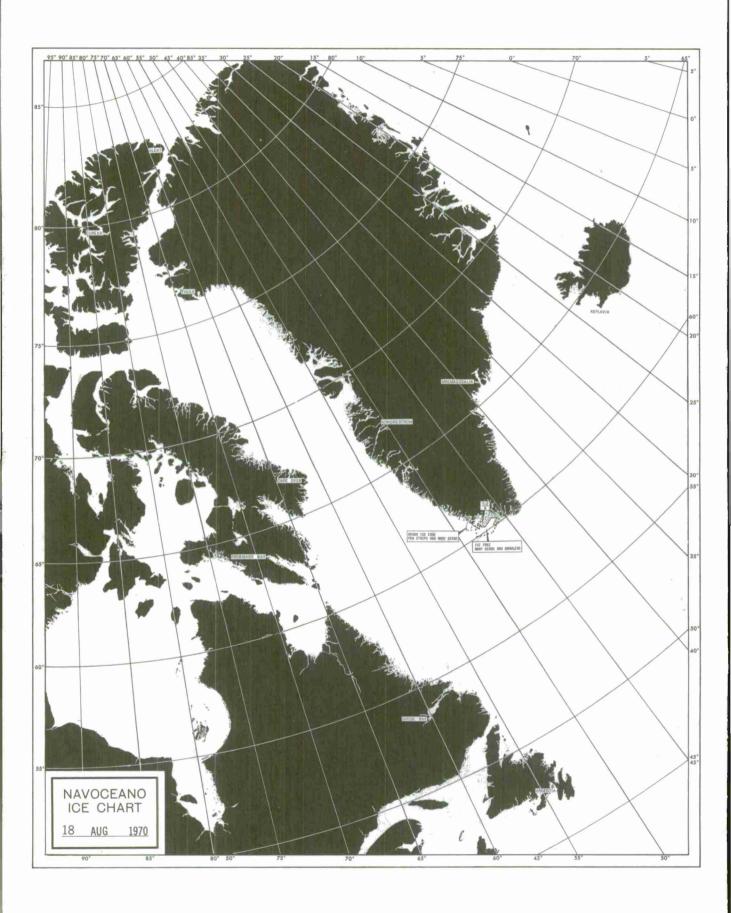


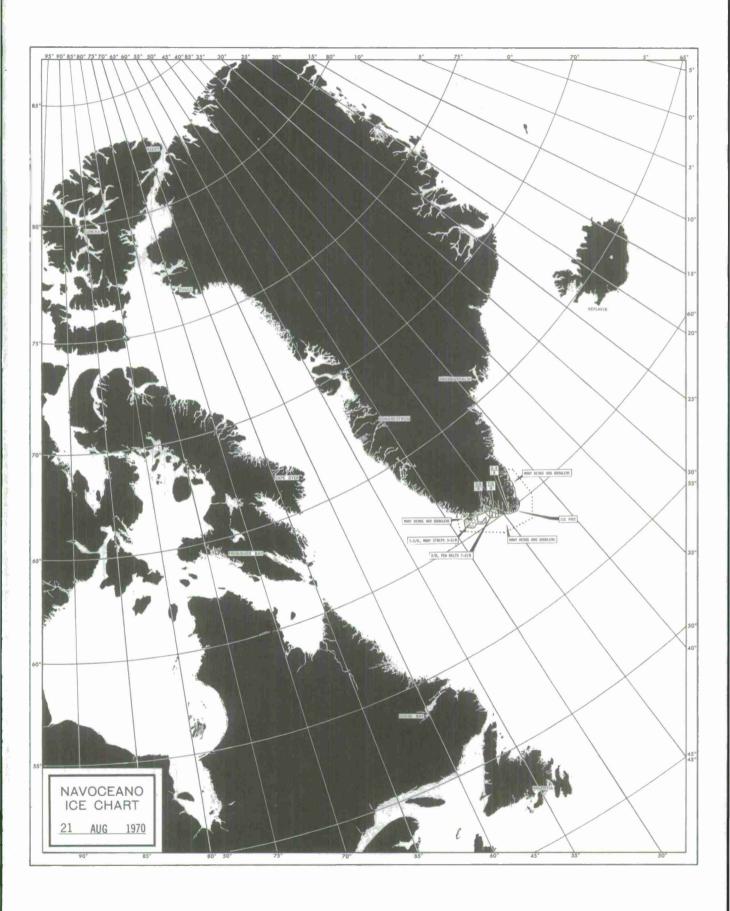


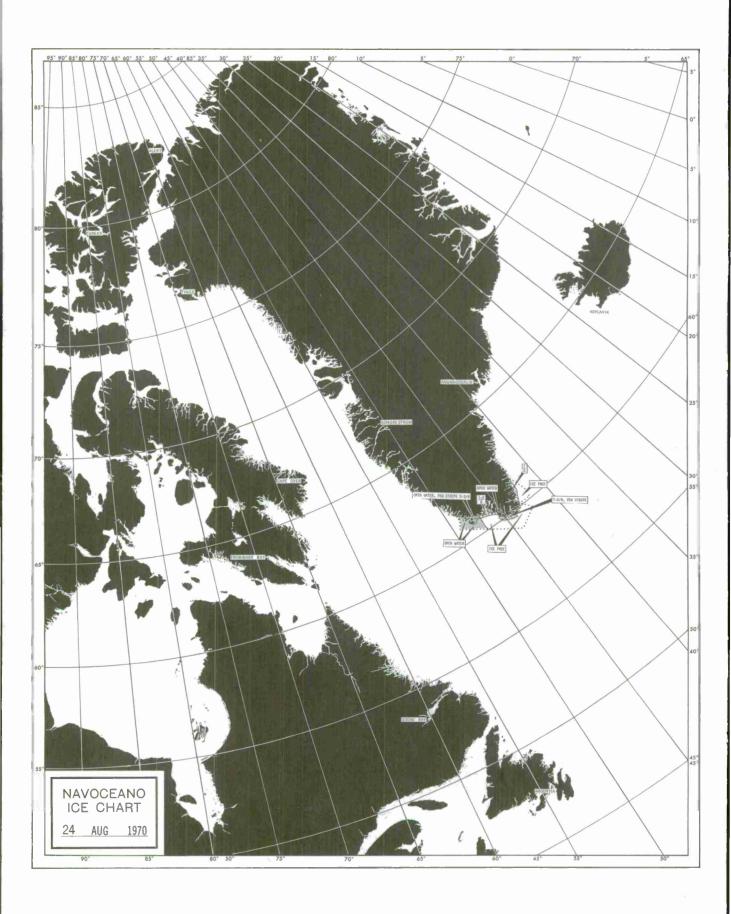


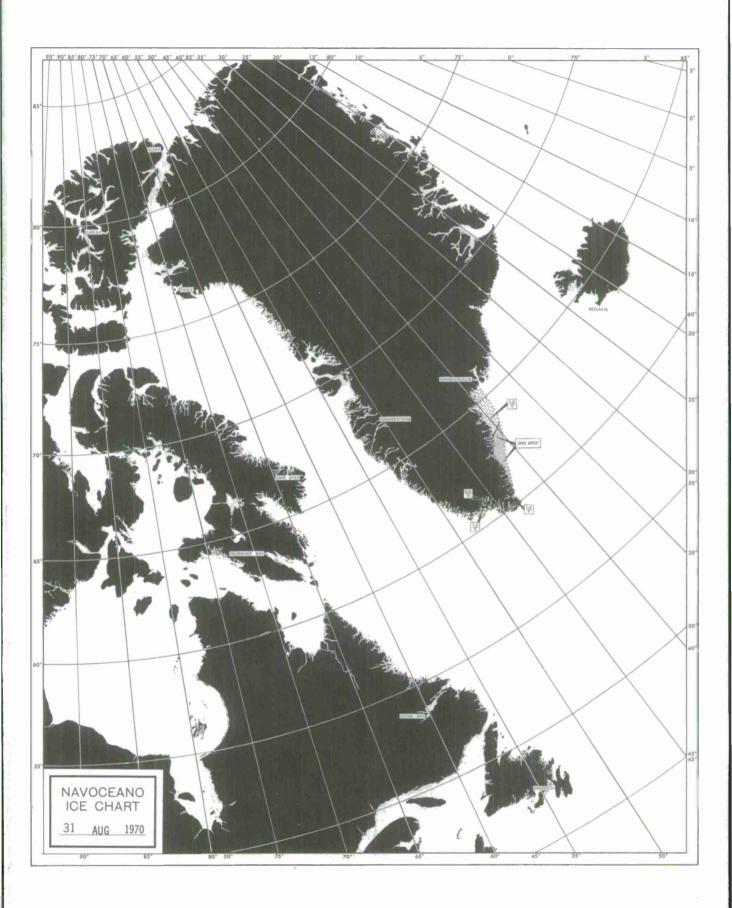


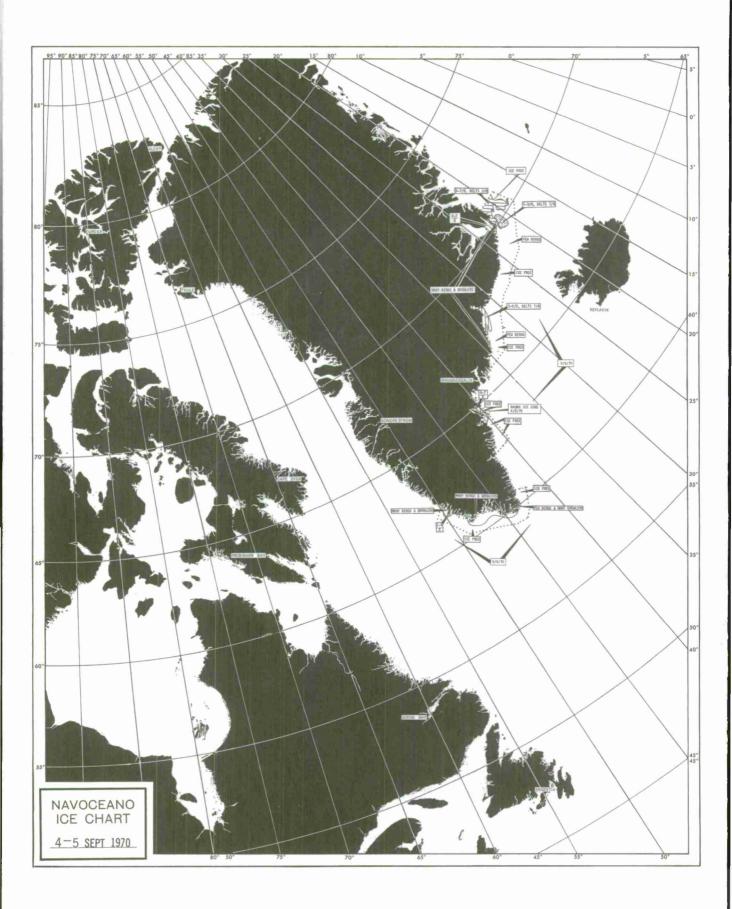


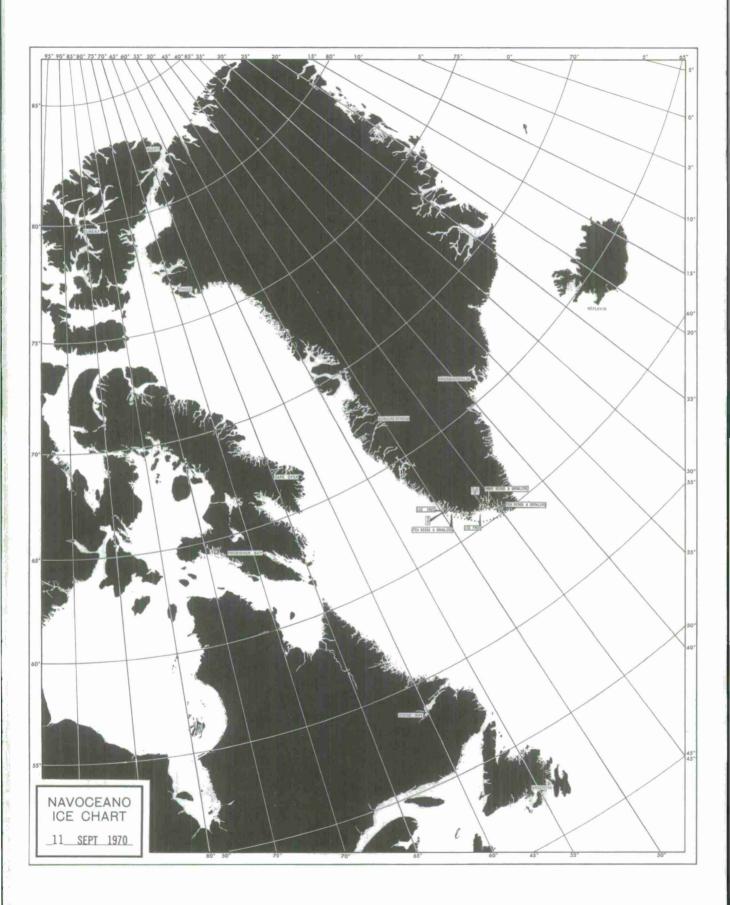


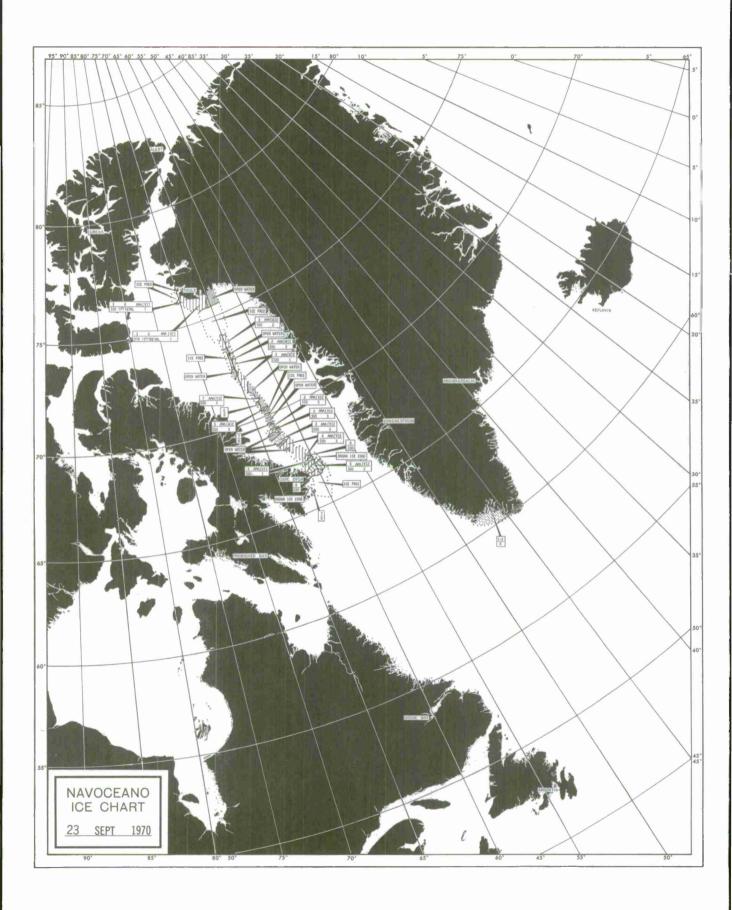


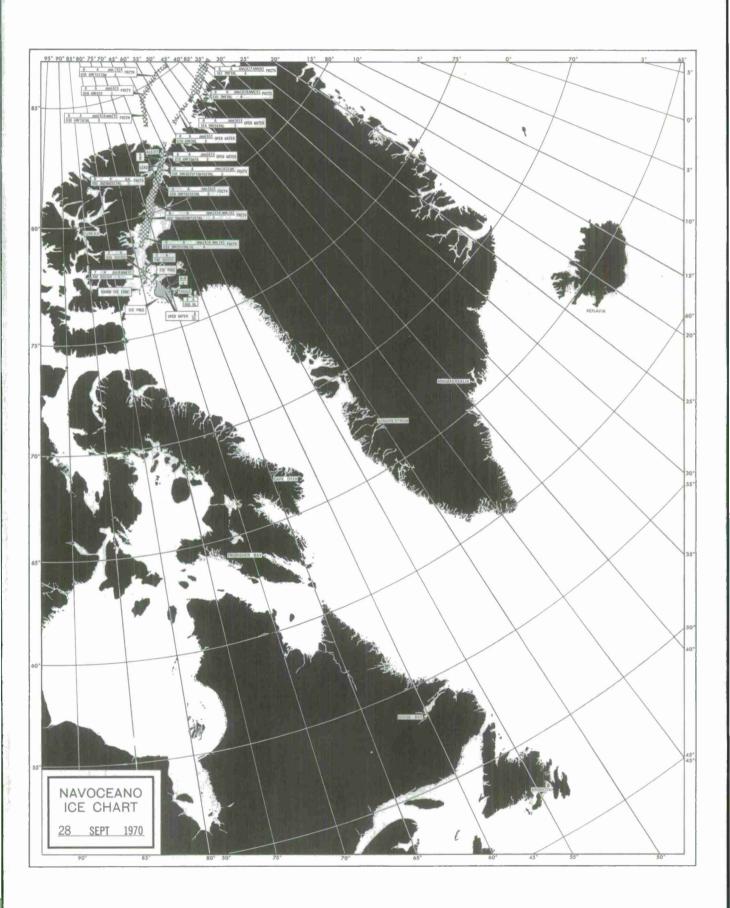


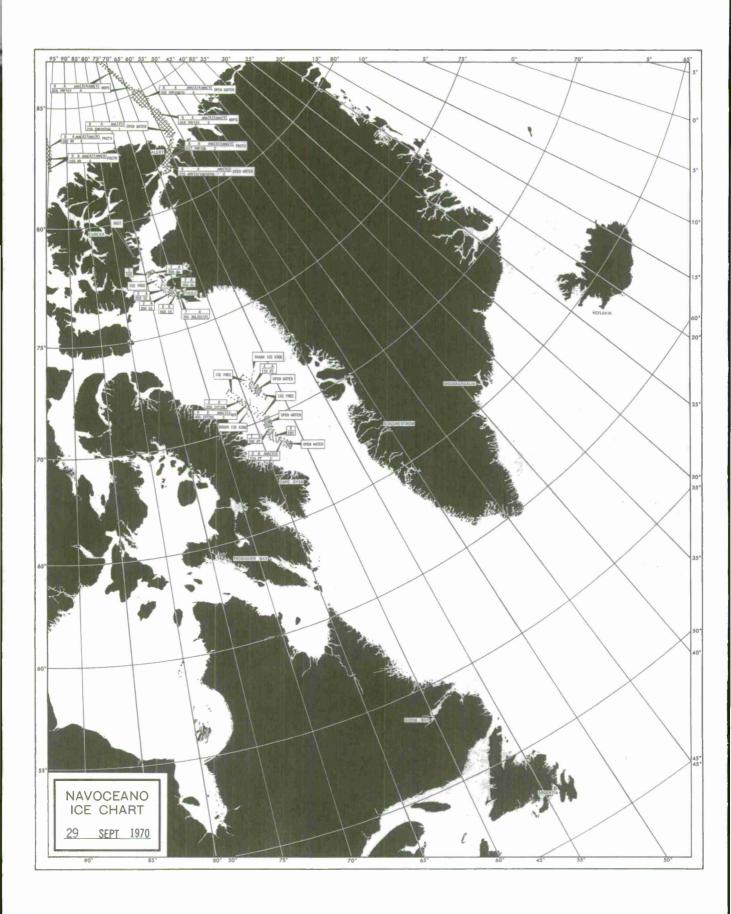


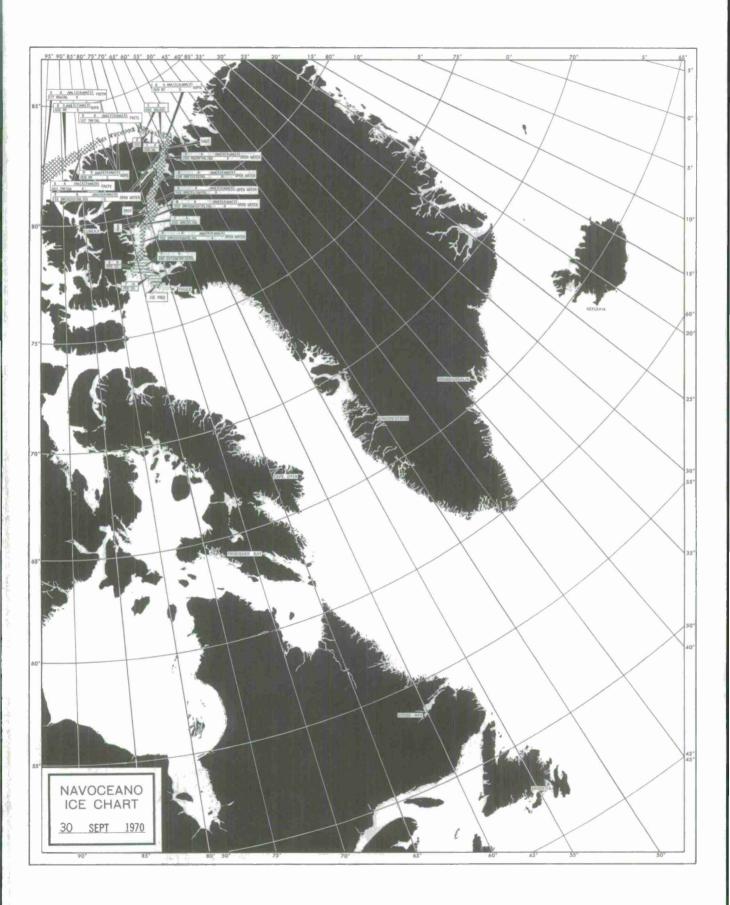


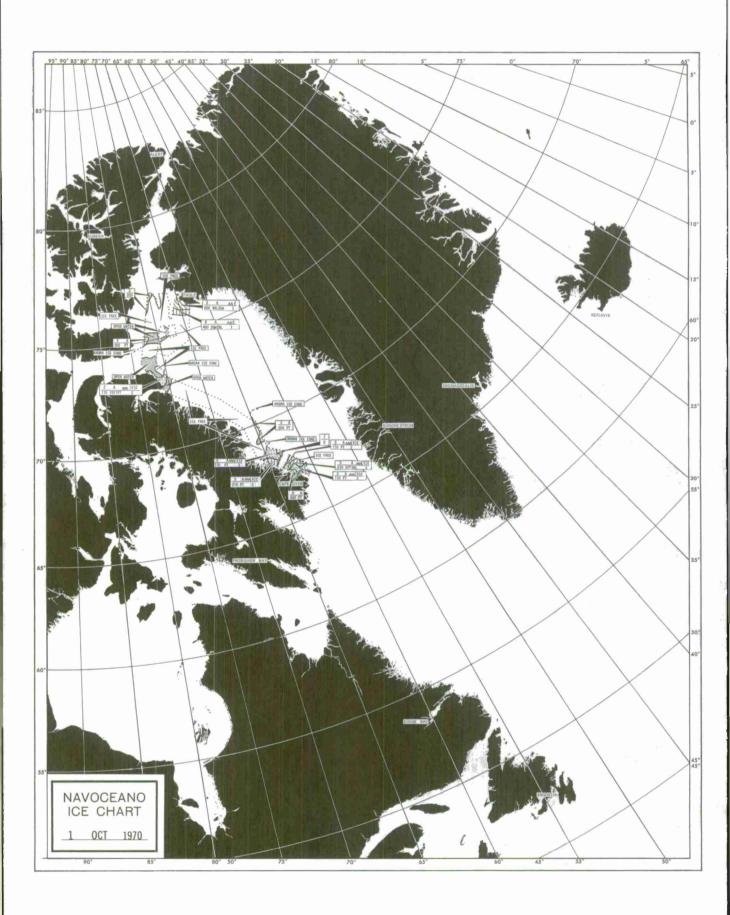


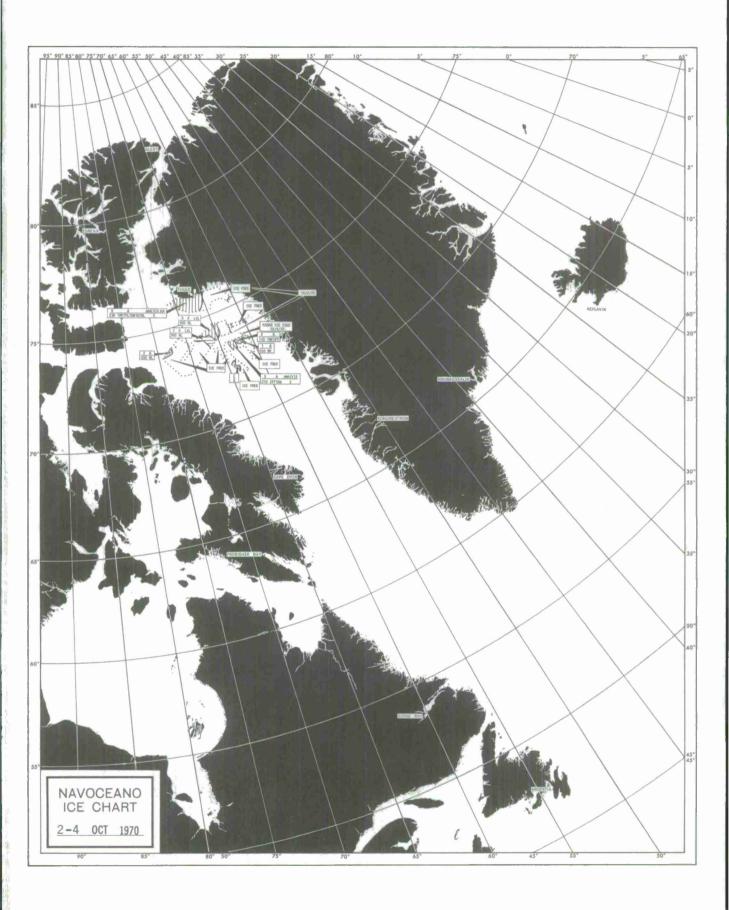


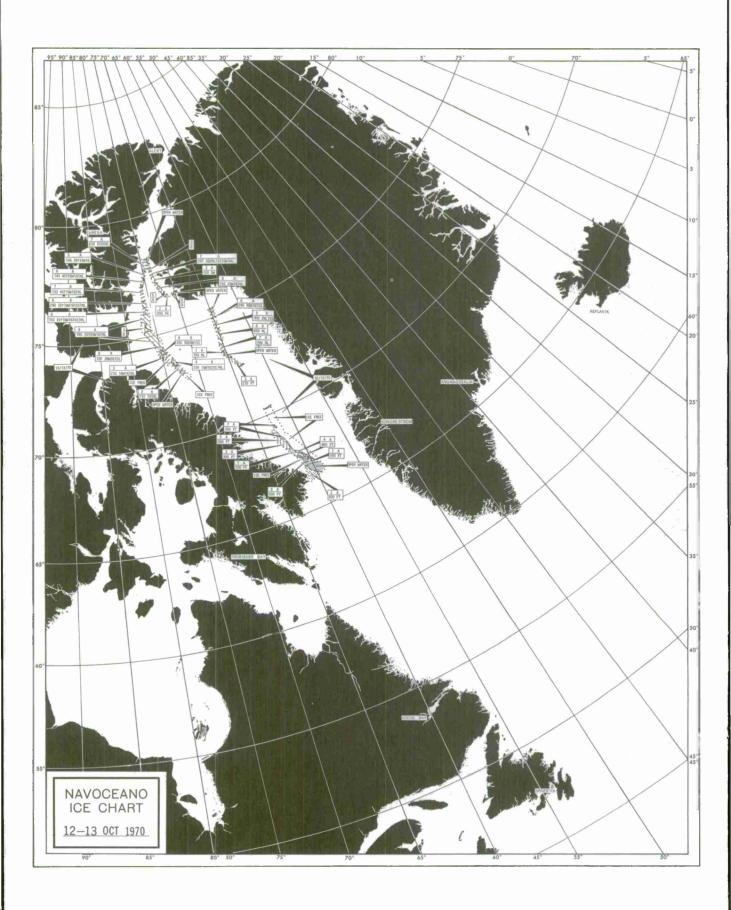


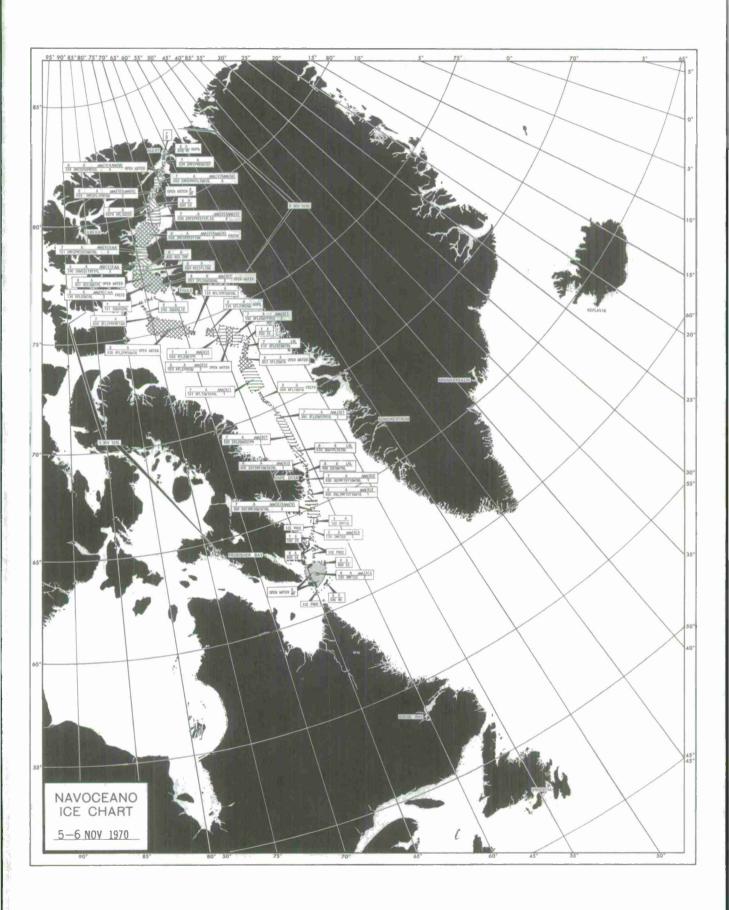


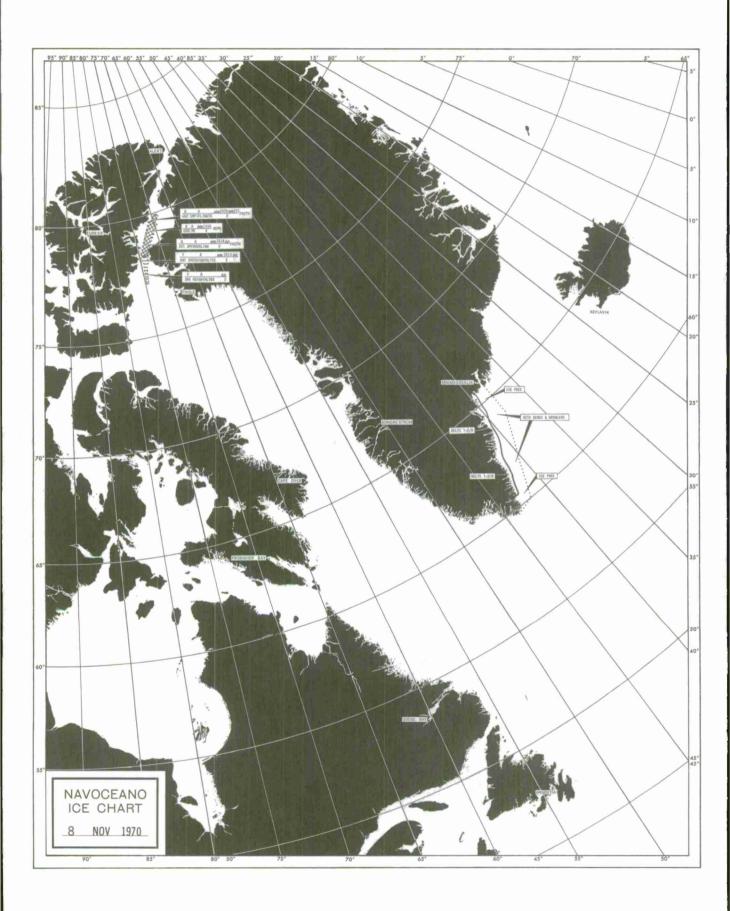


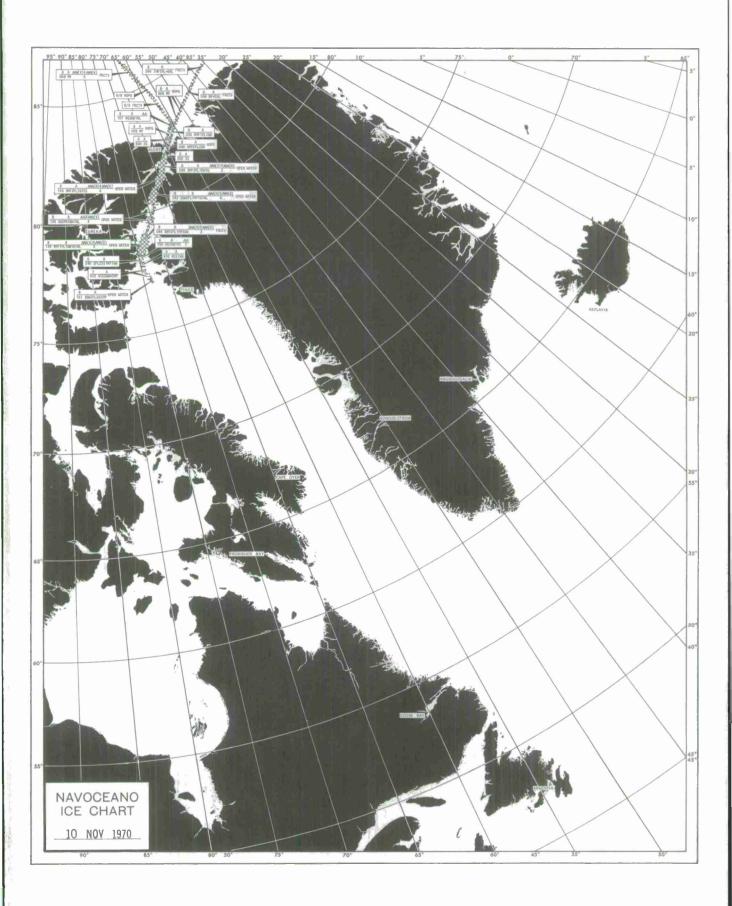


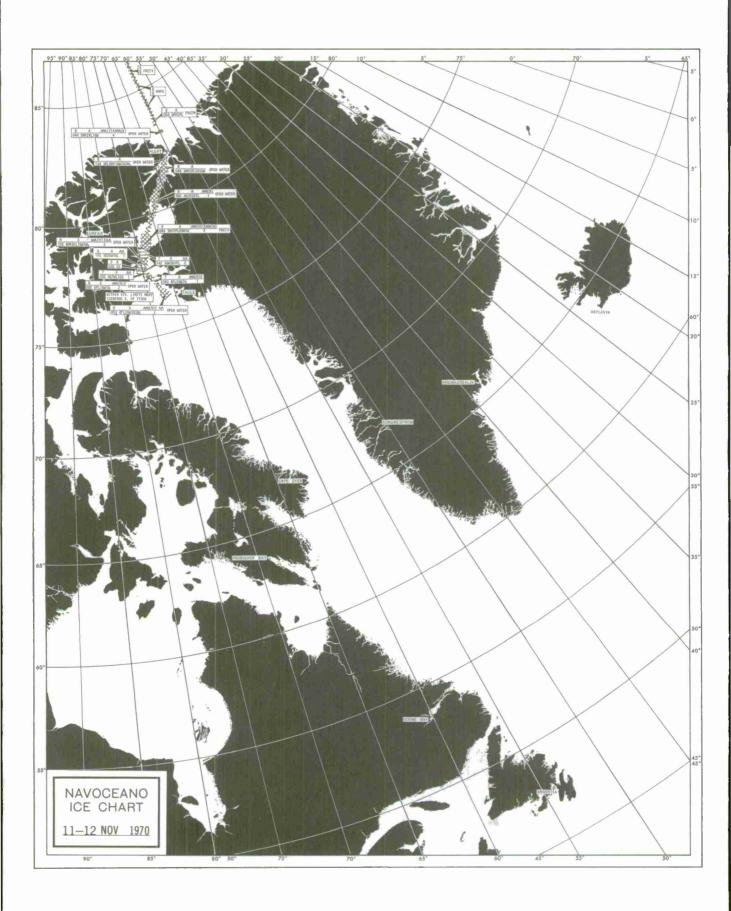


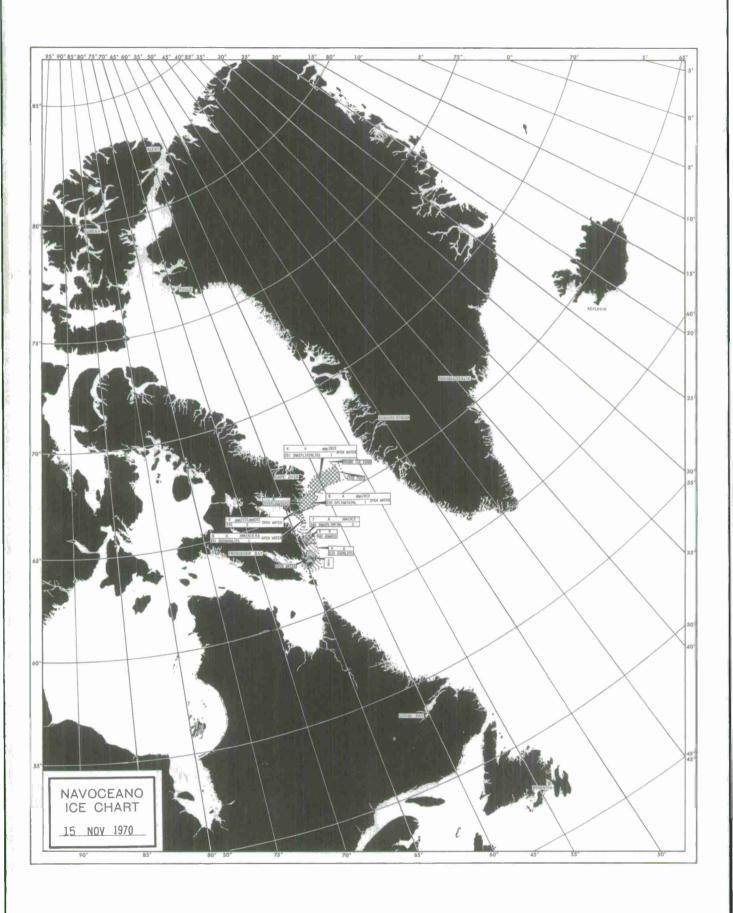


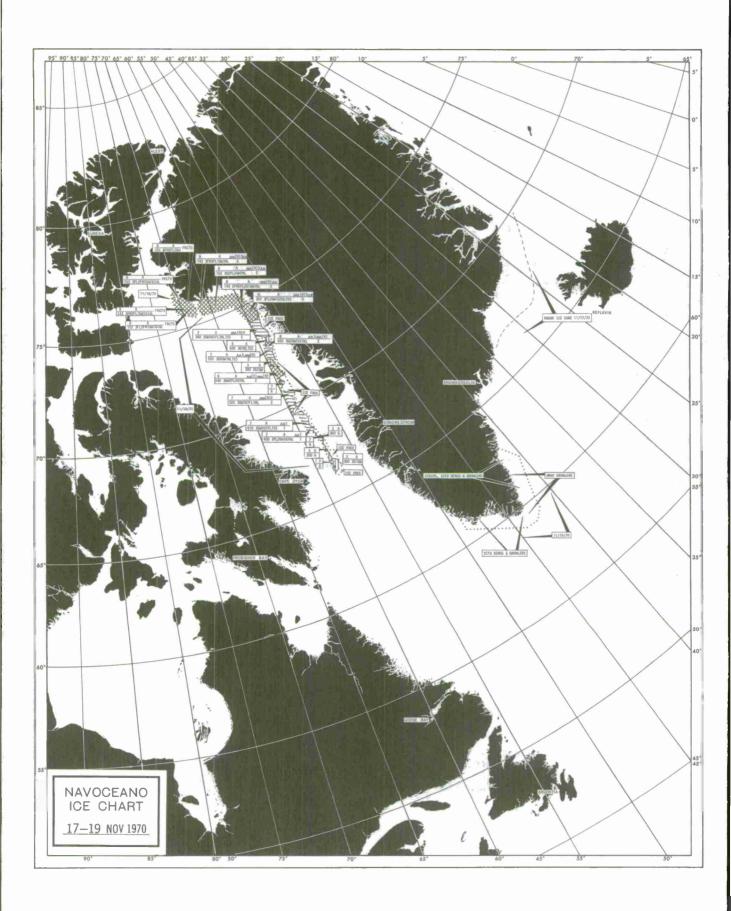


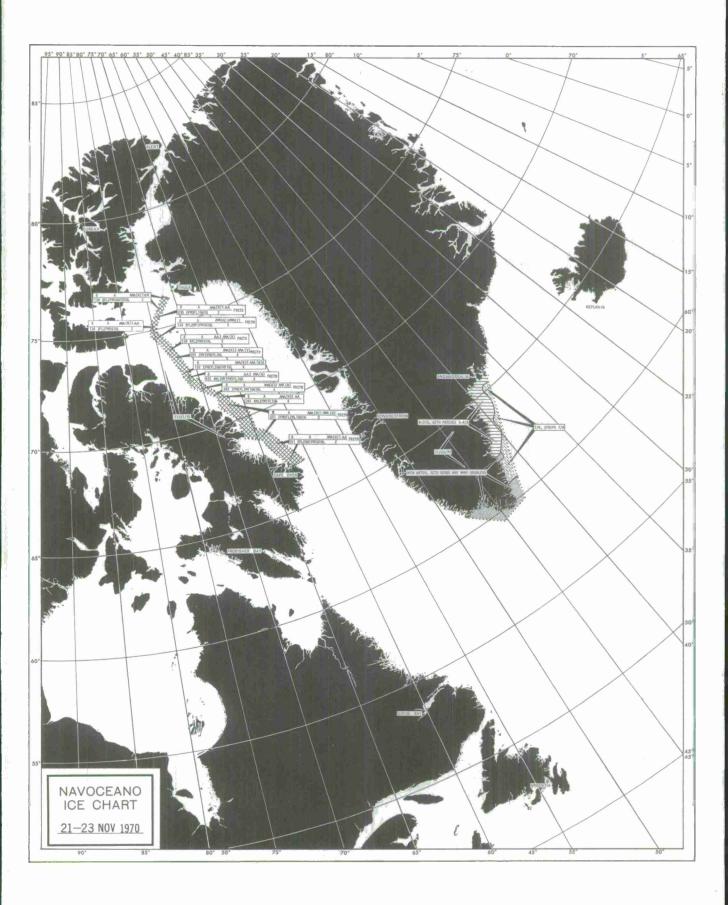


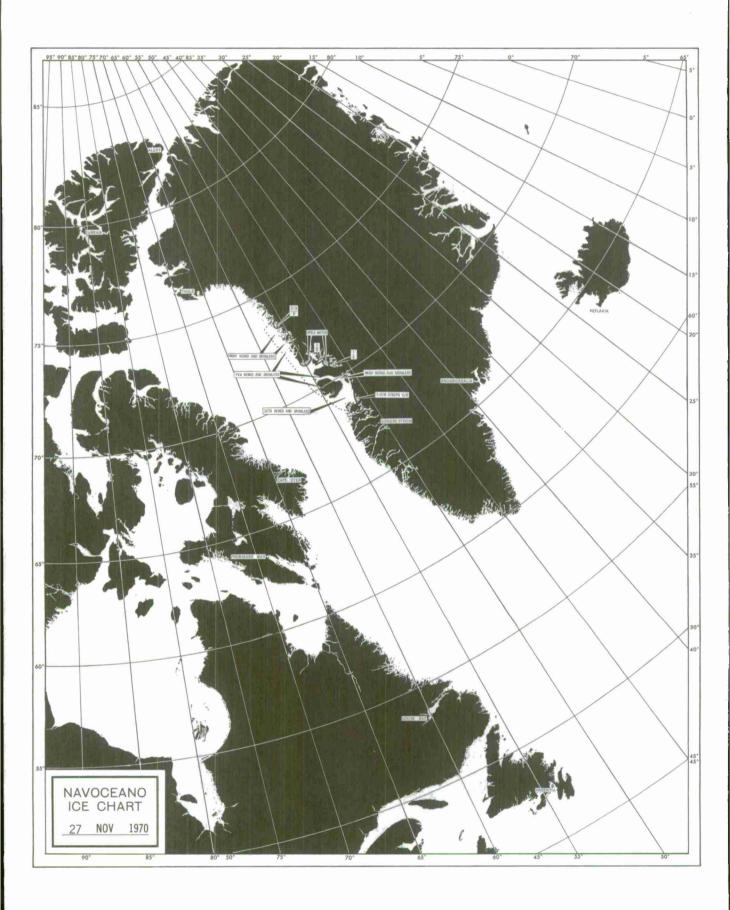


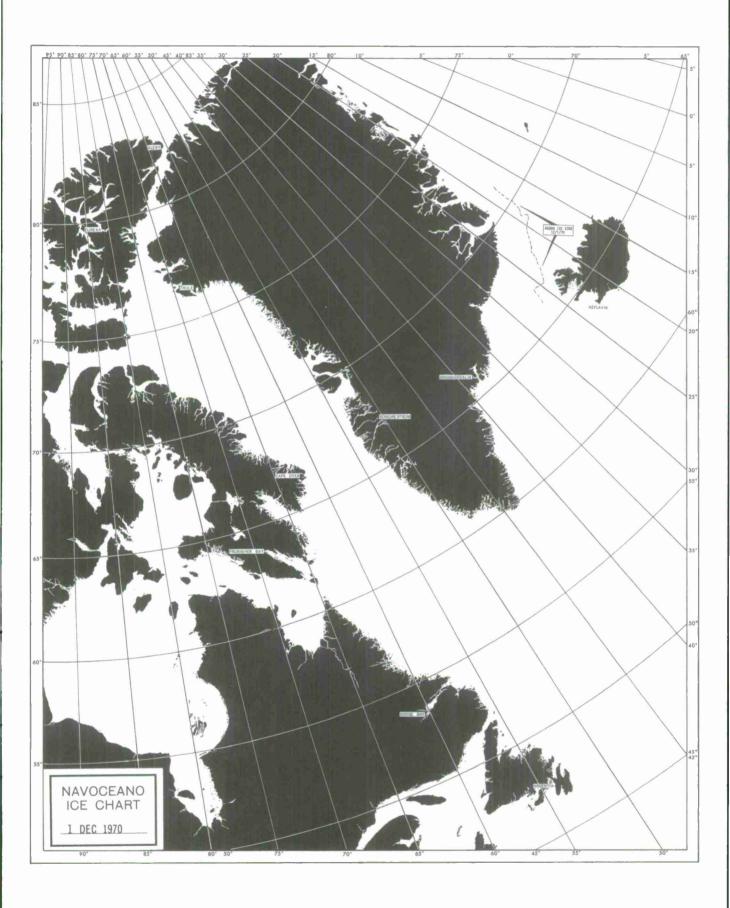


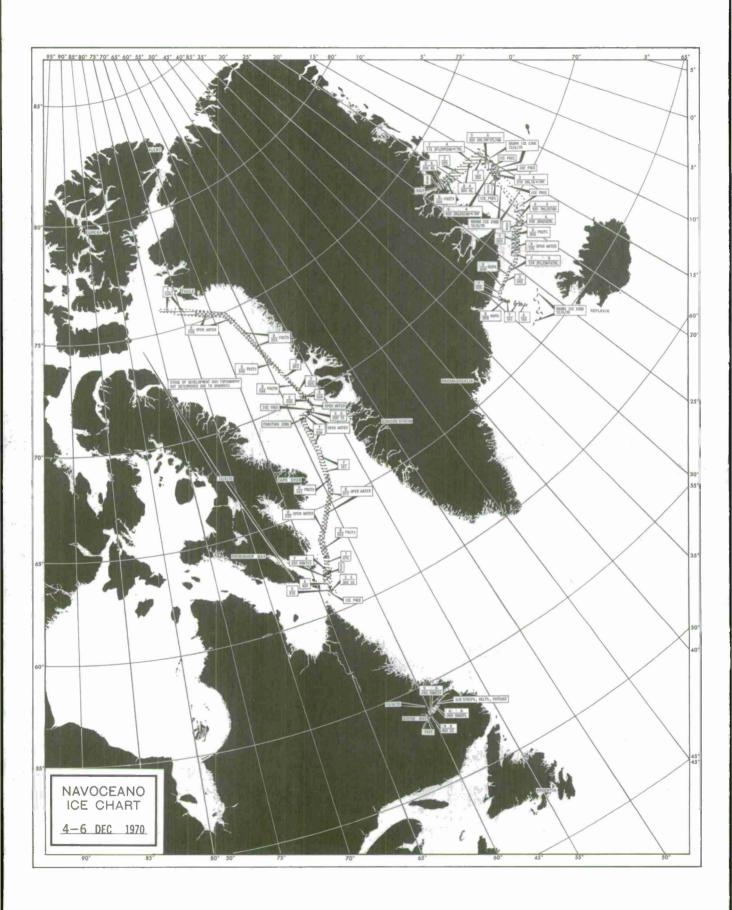


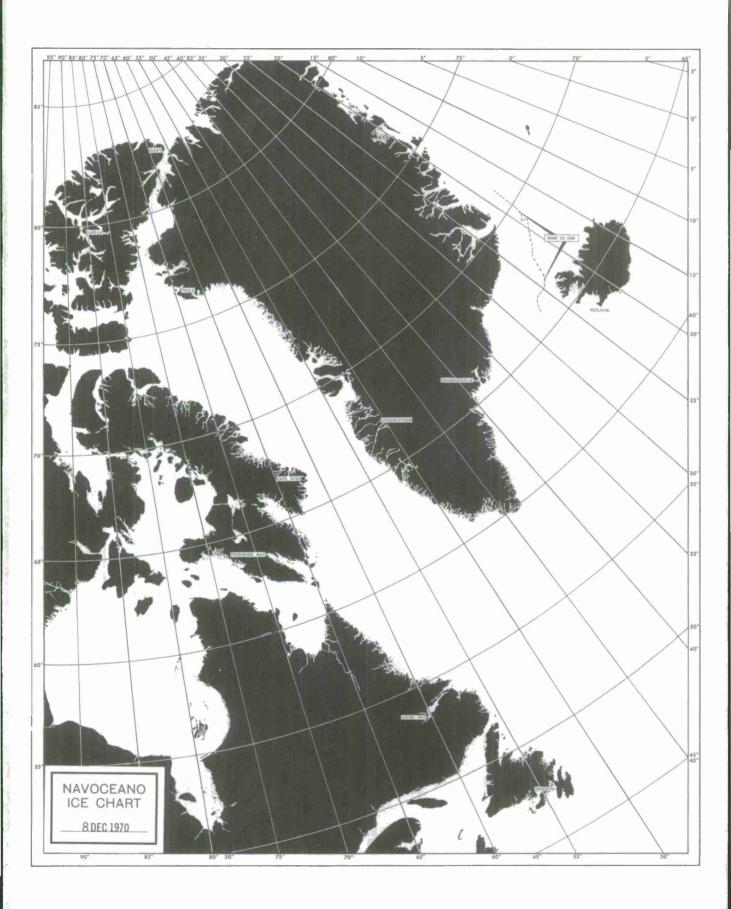


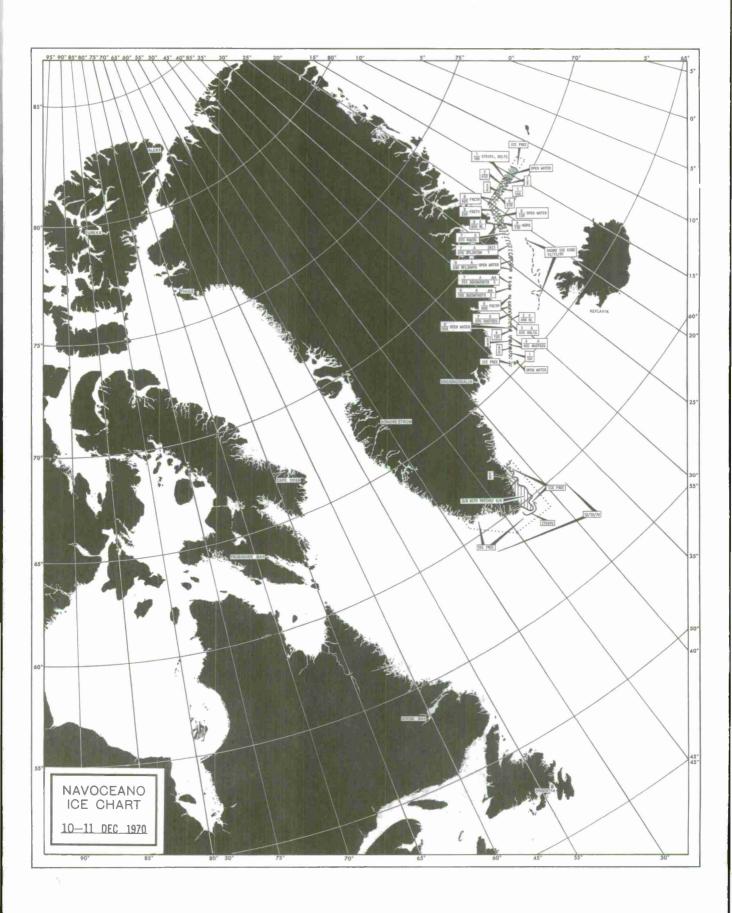


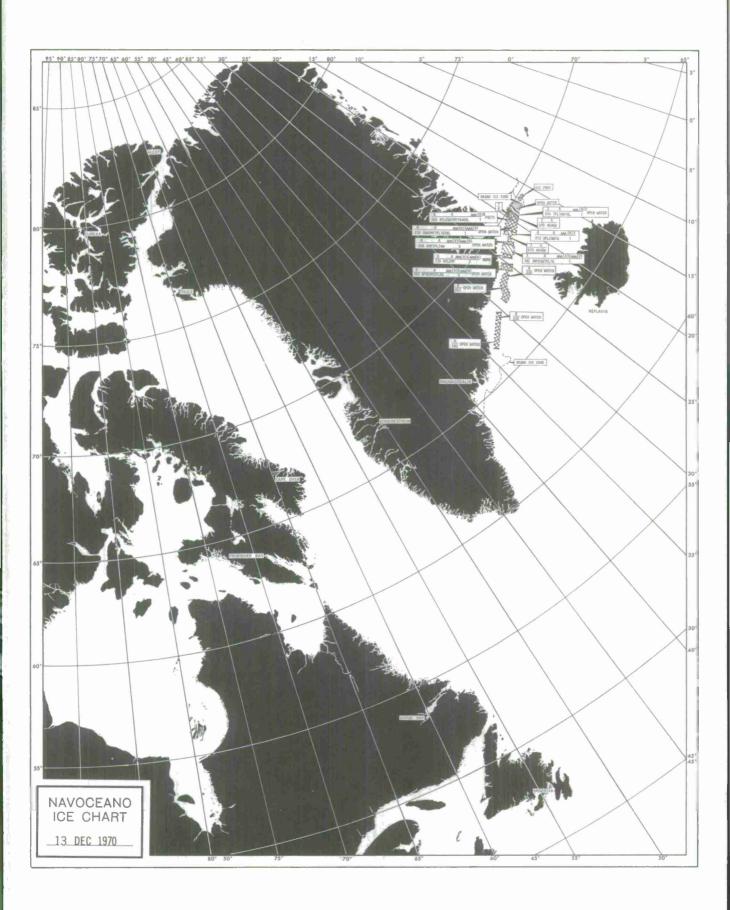


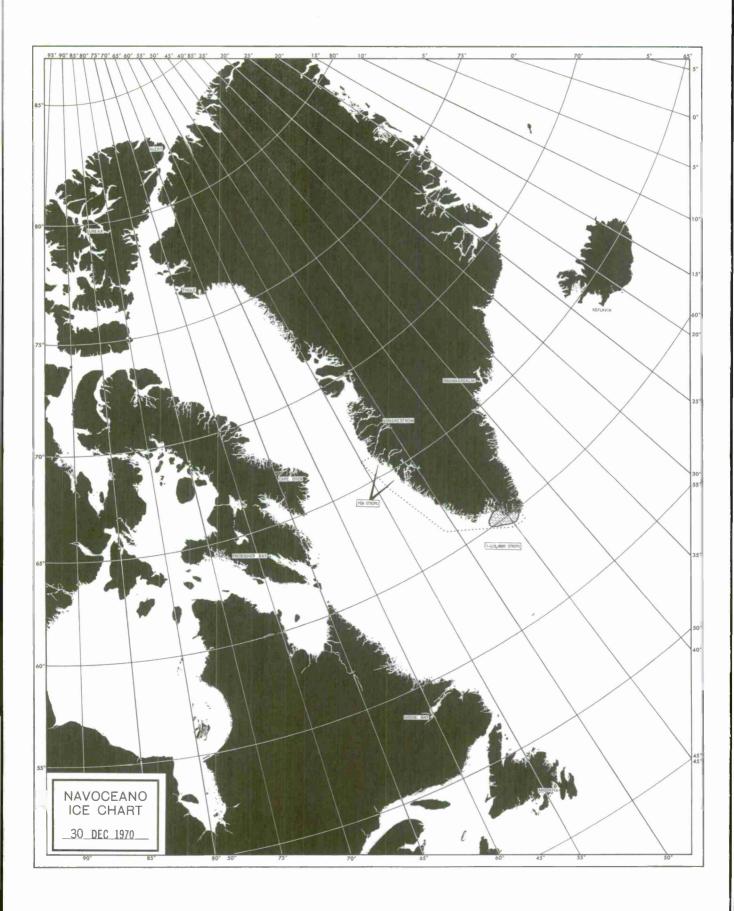




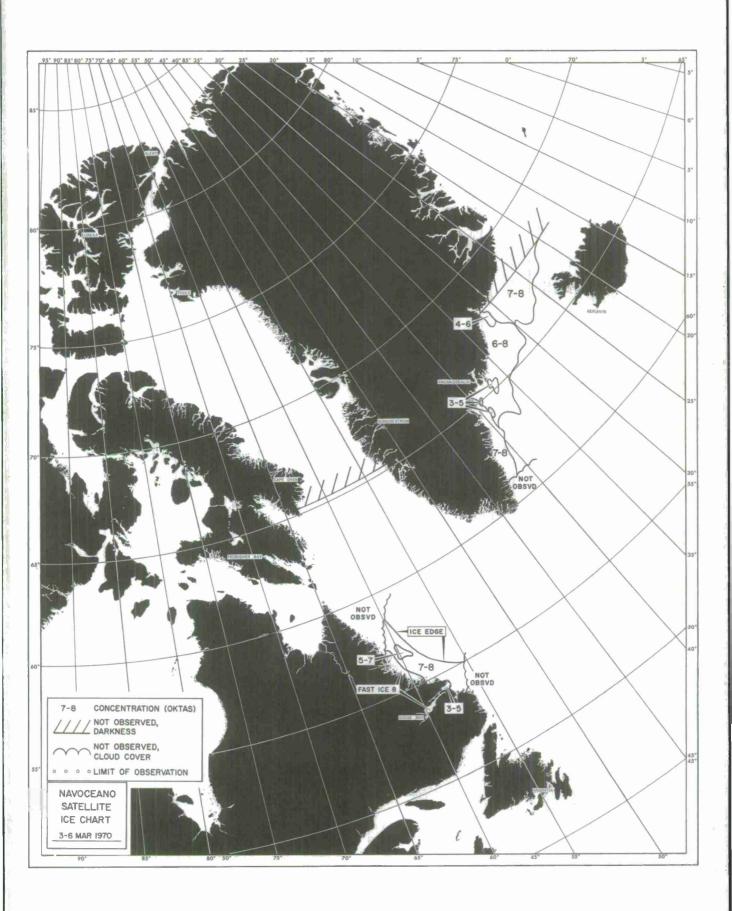


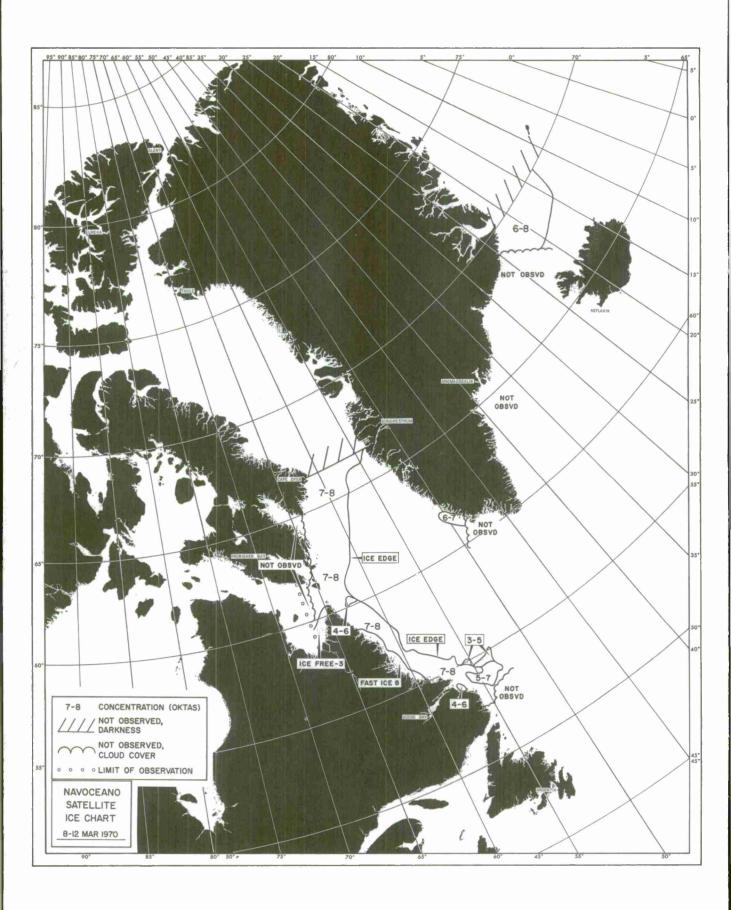


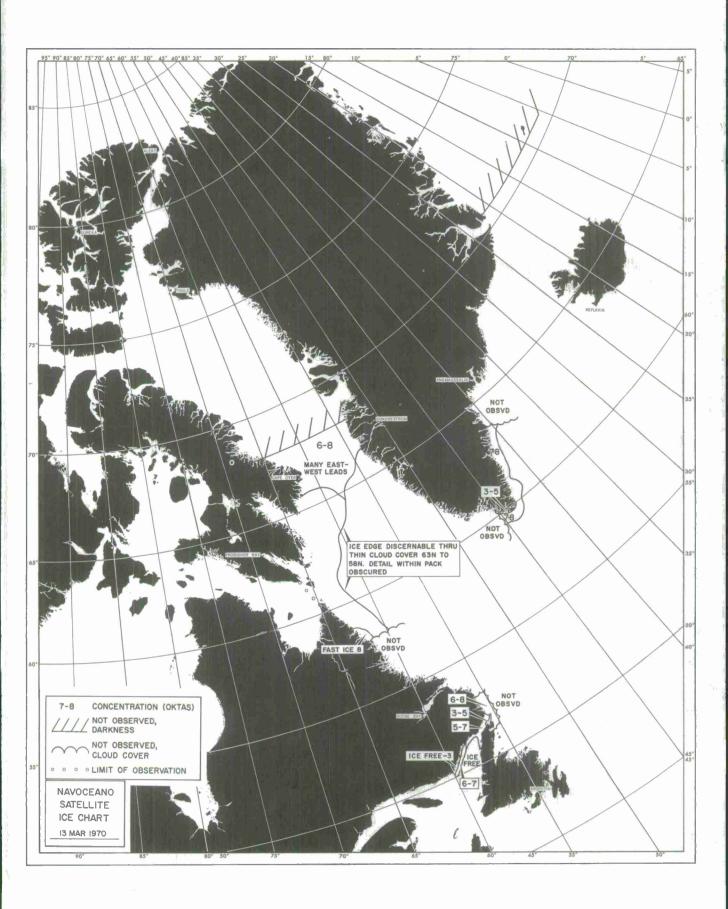


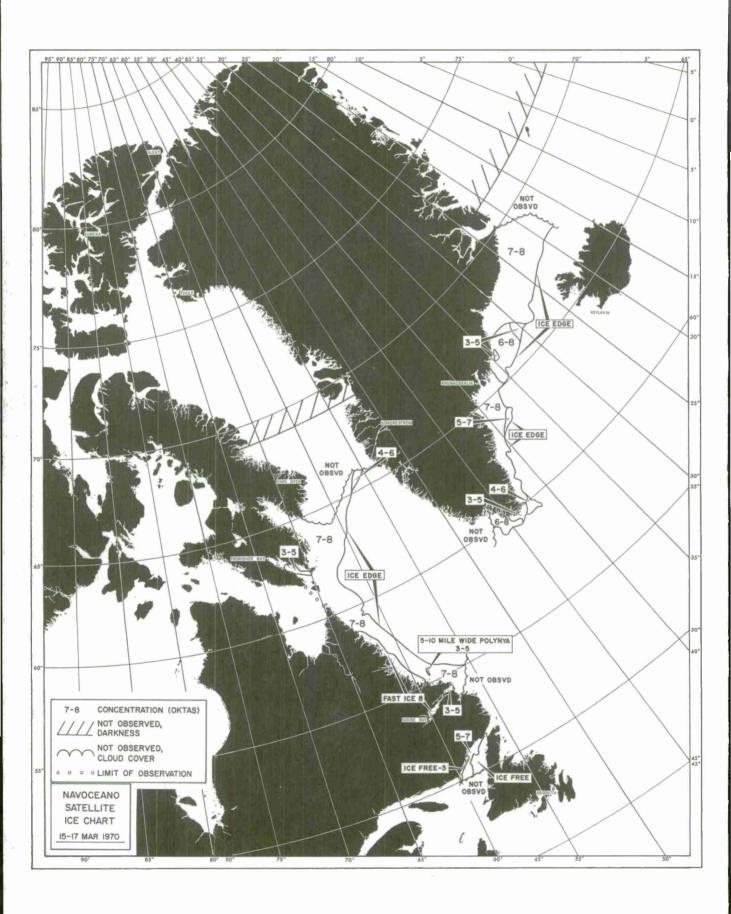


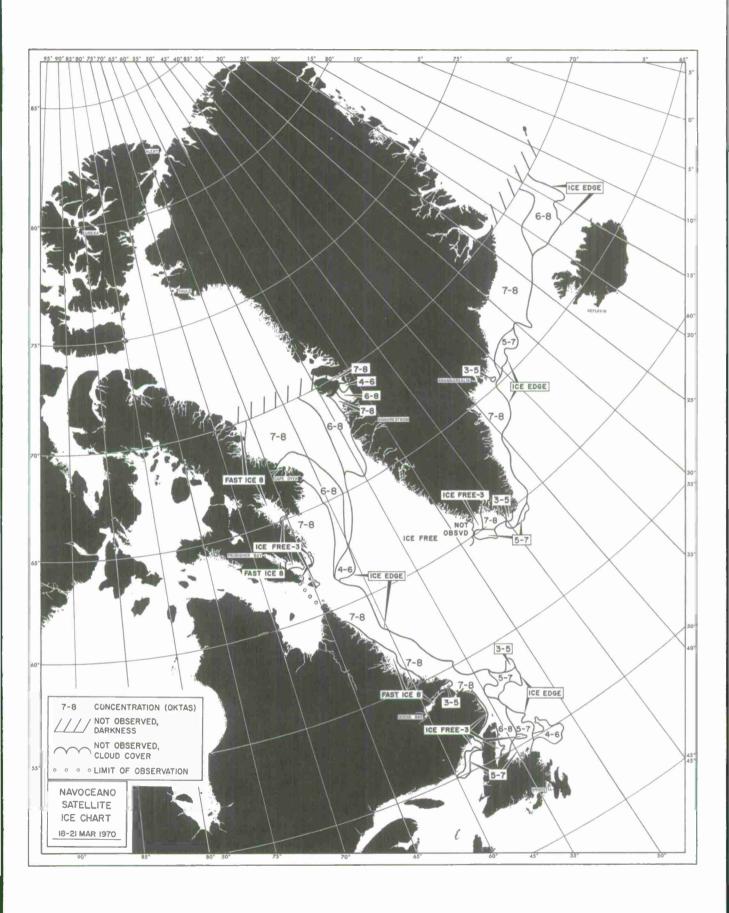
APPENDIX B EASTERN ARCTIC ICE CHARTS OBSERVED BY SATELLITE

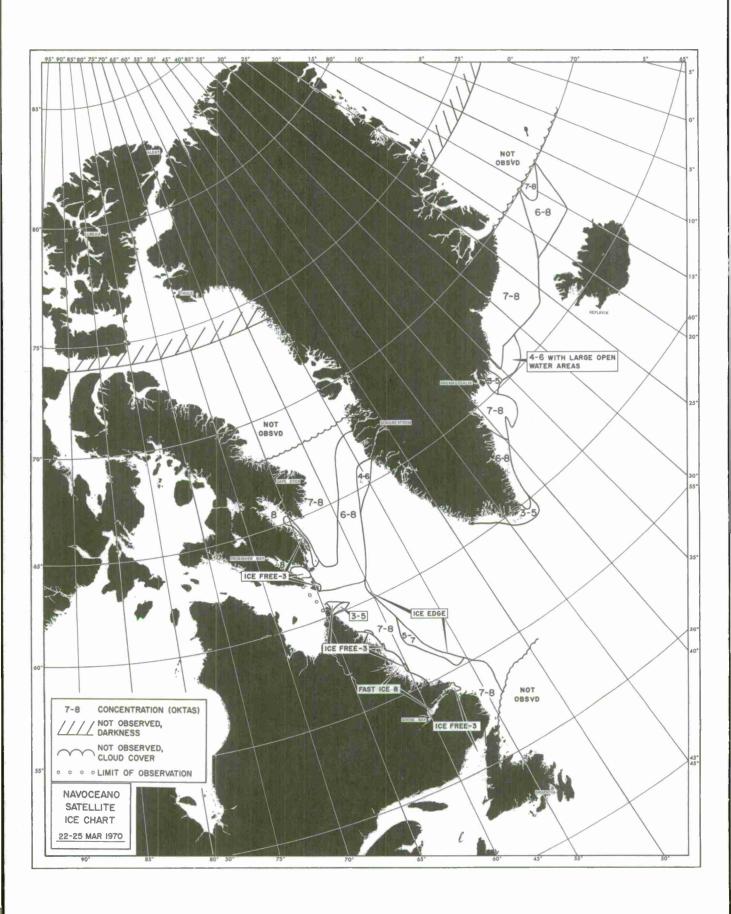


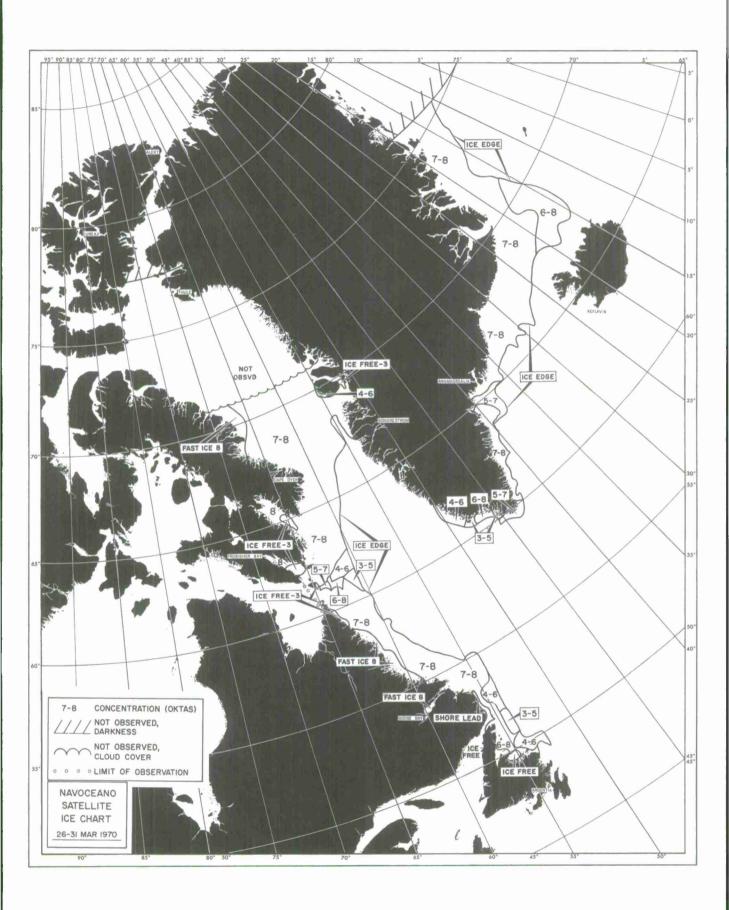


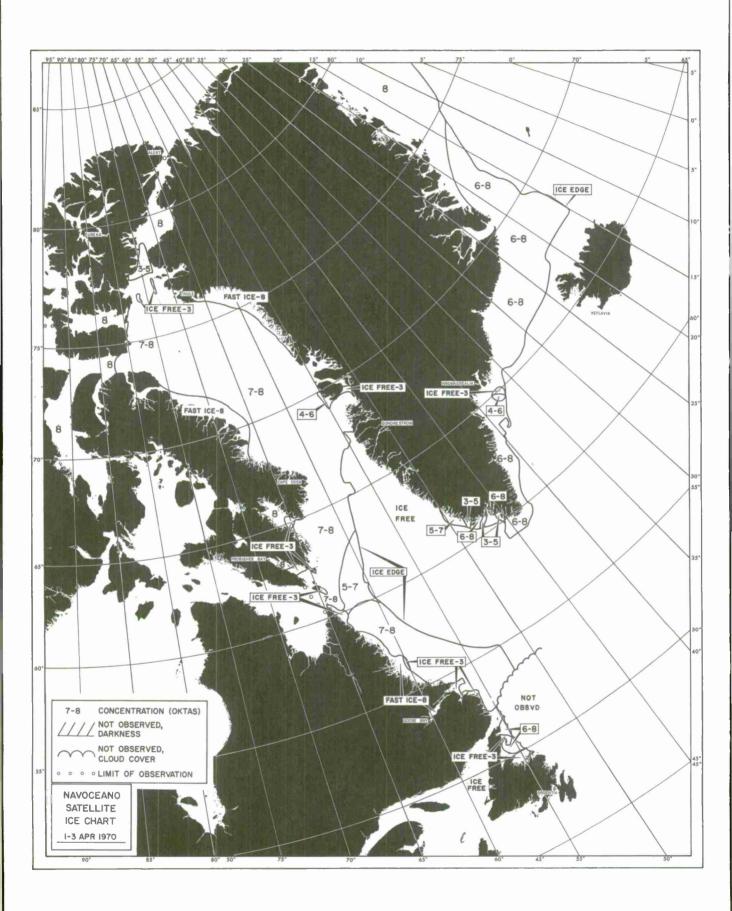


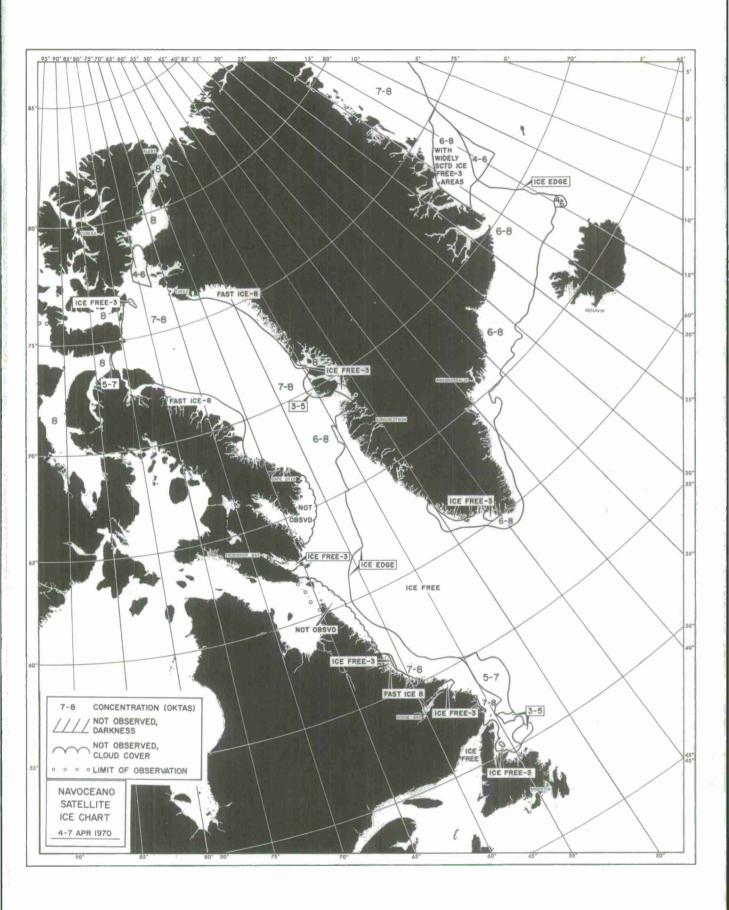


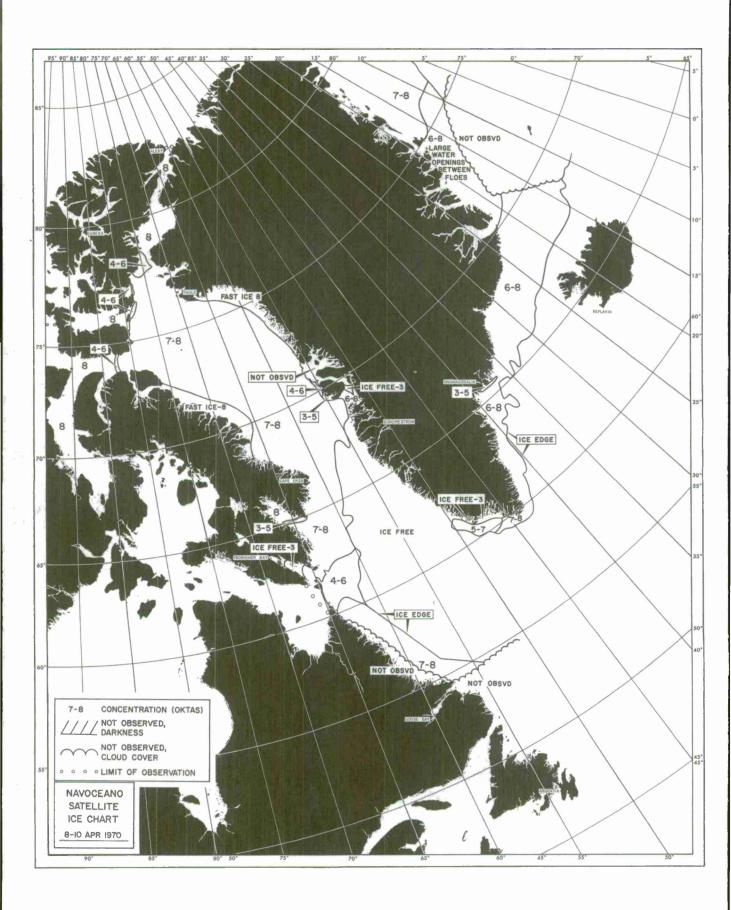


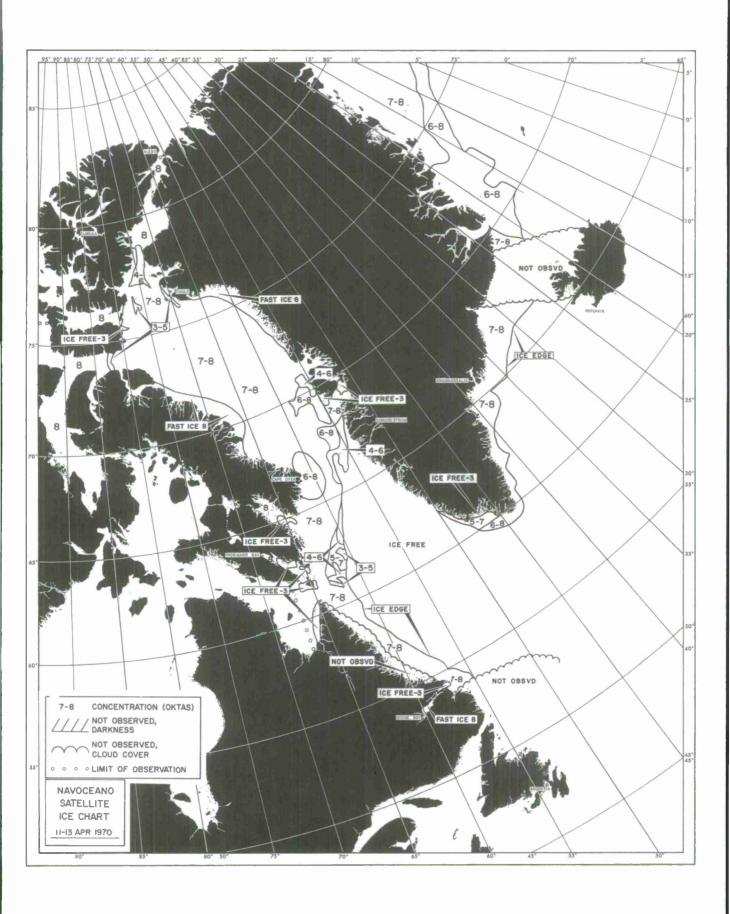


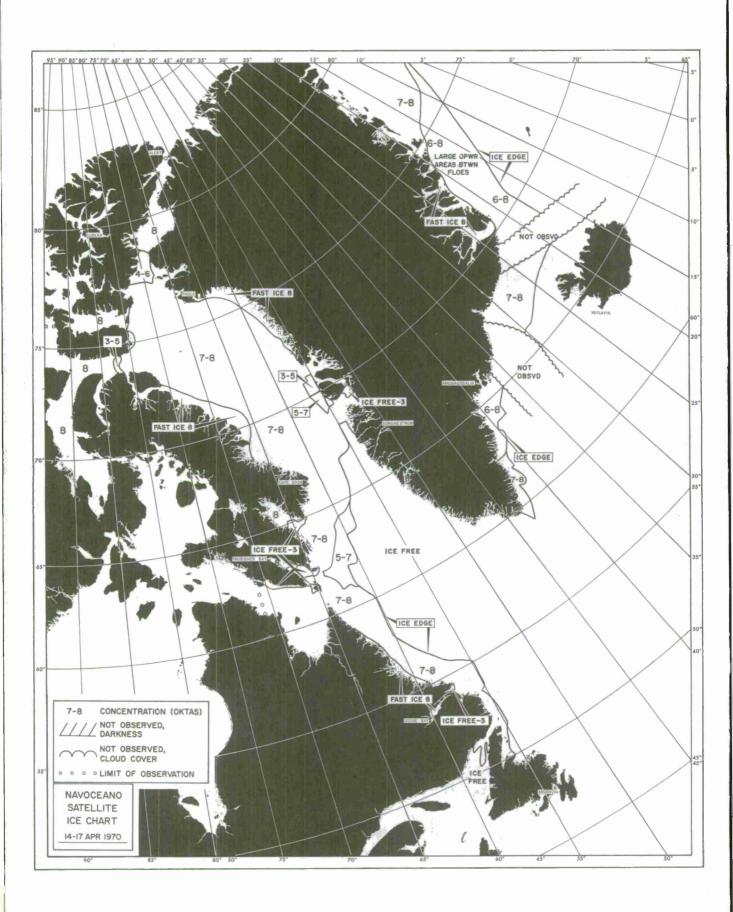


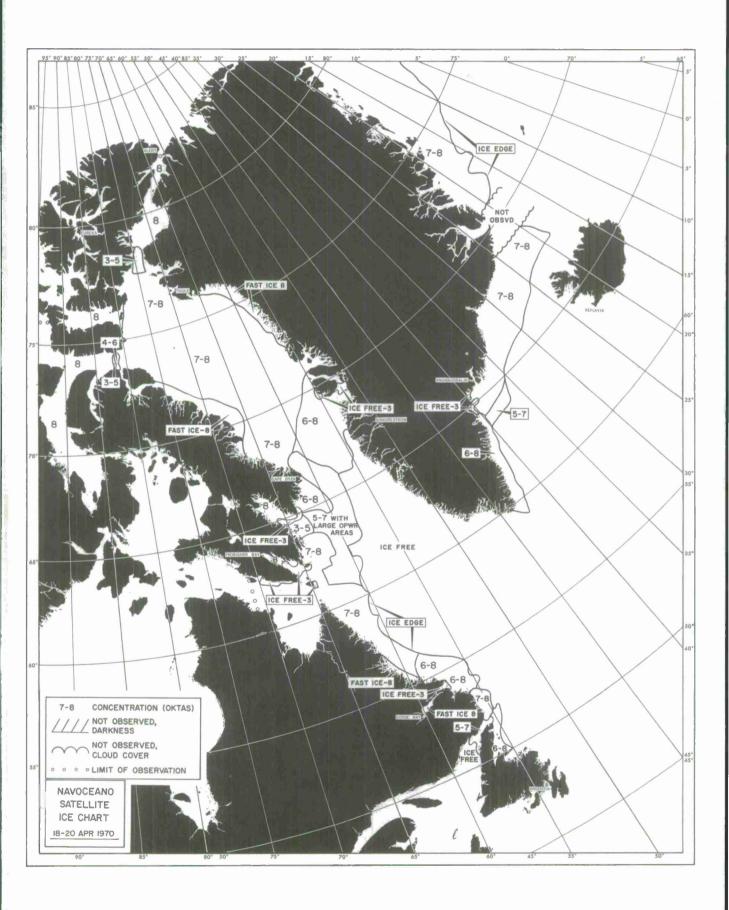


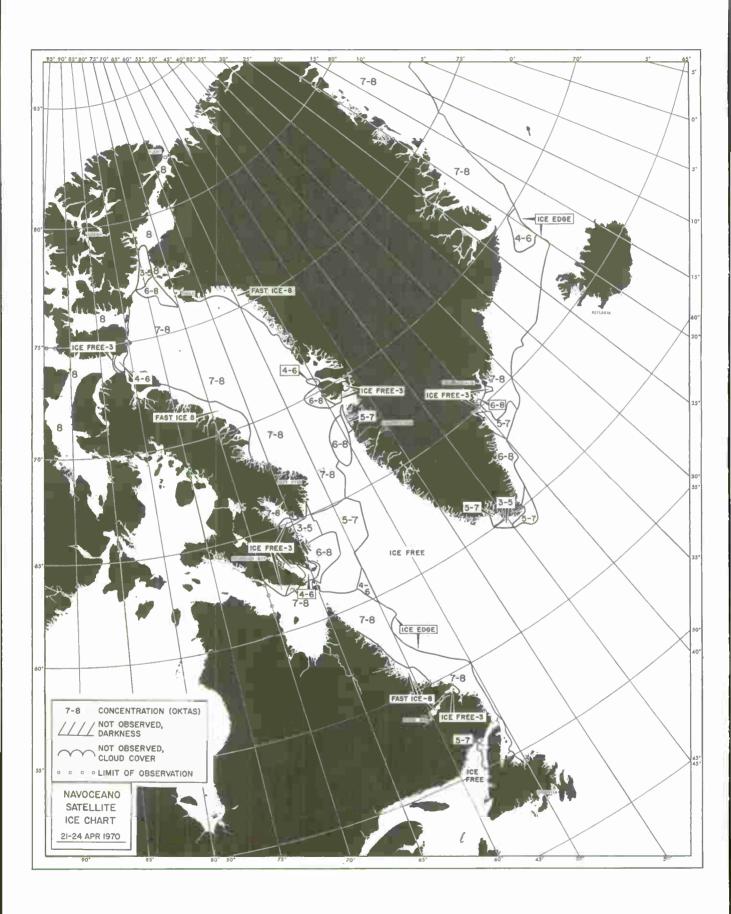


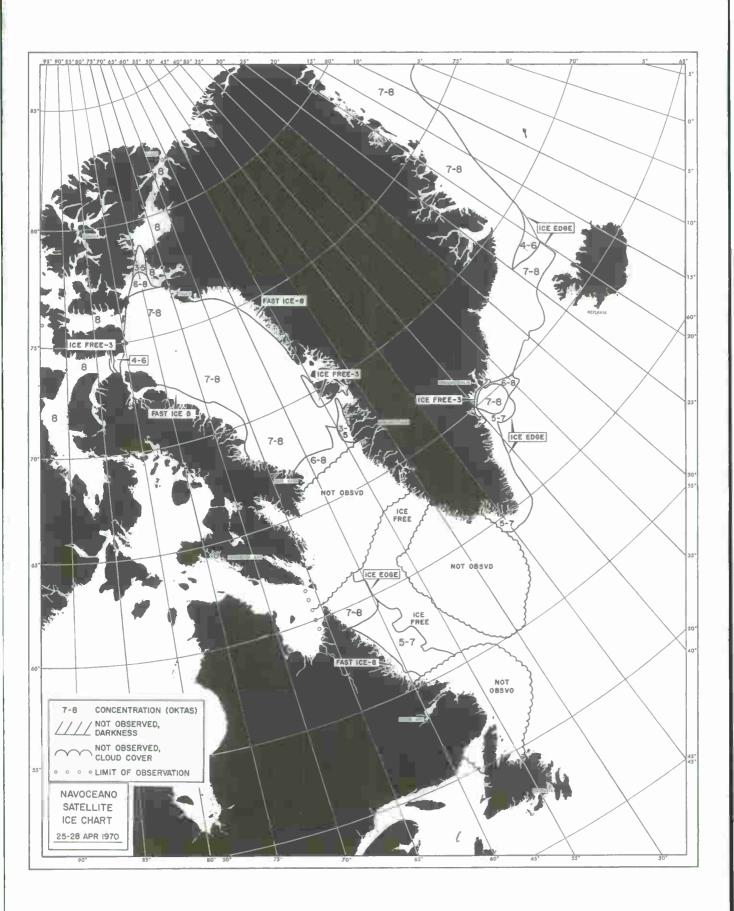


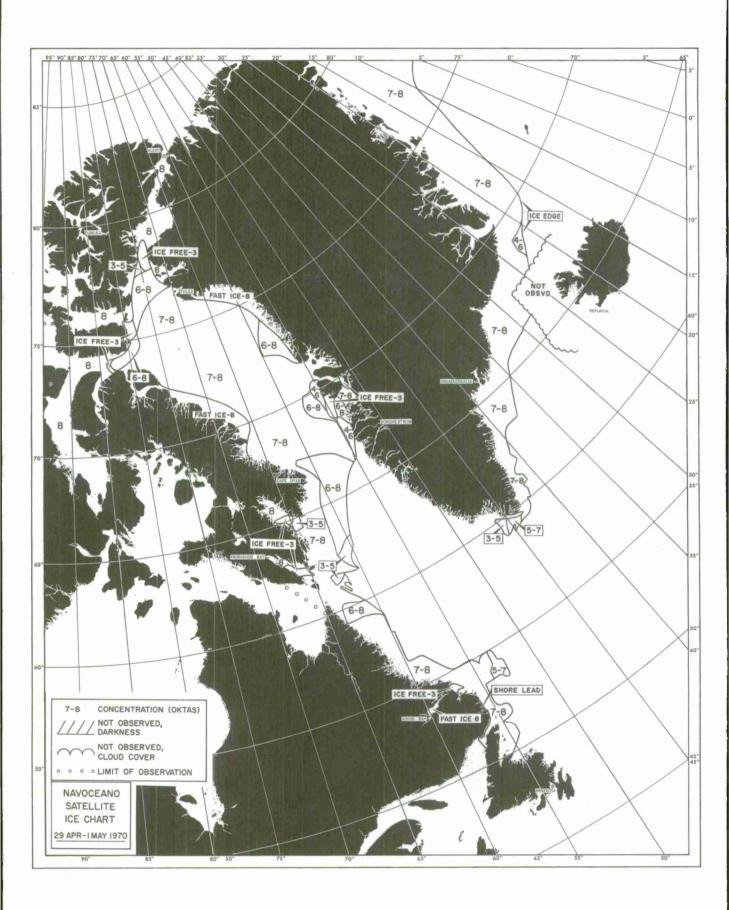


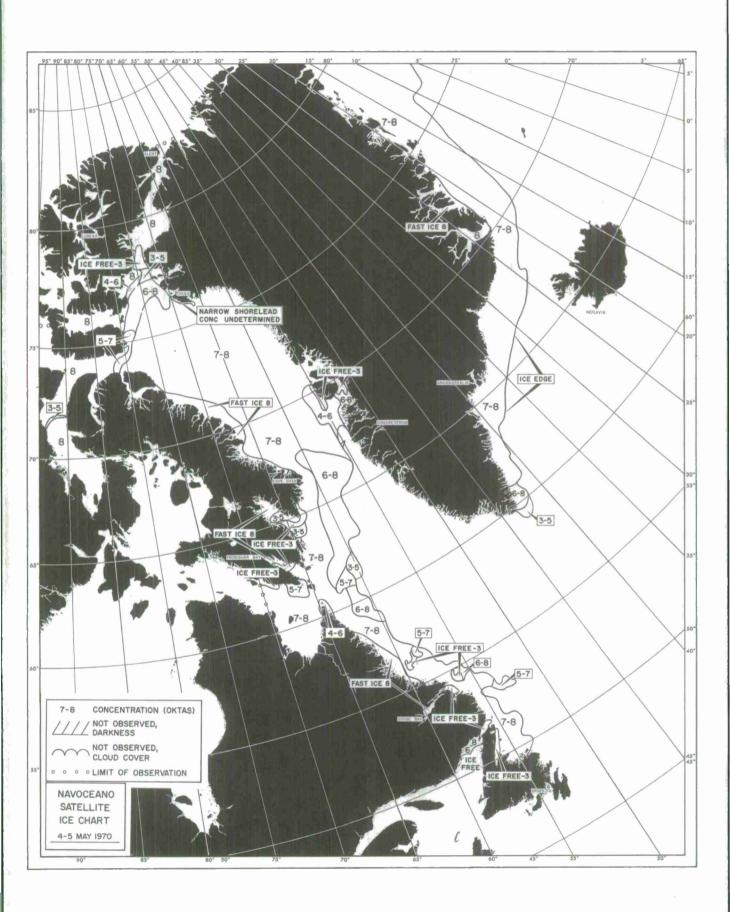


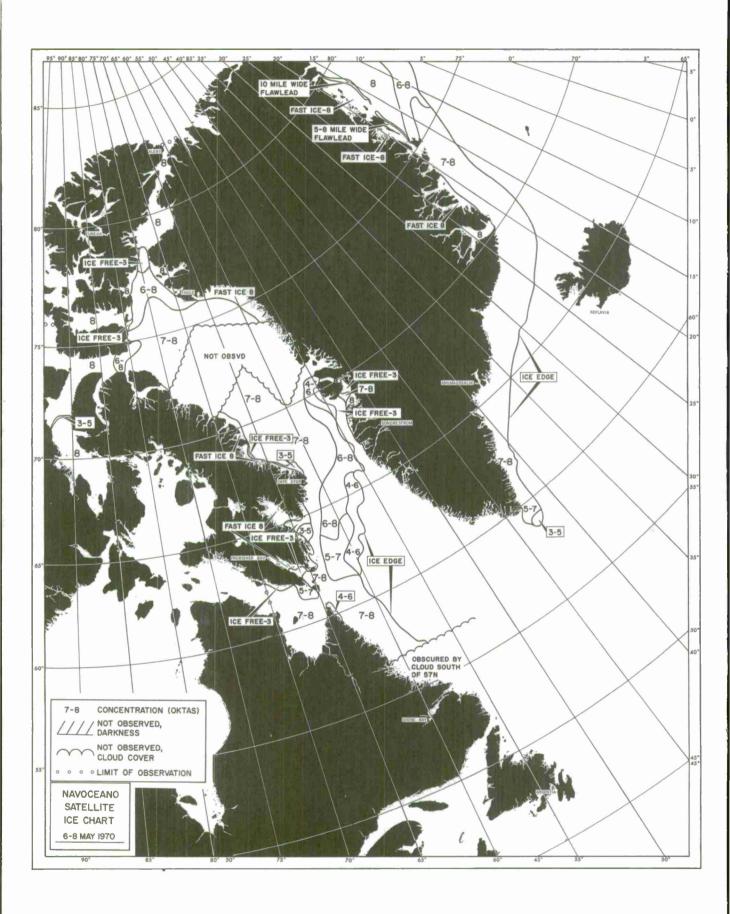


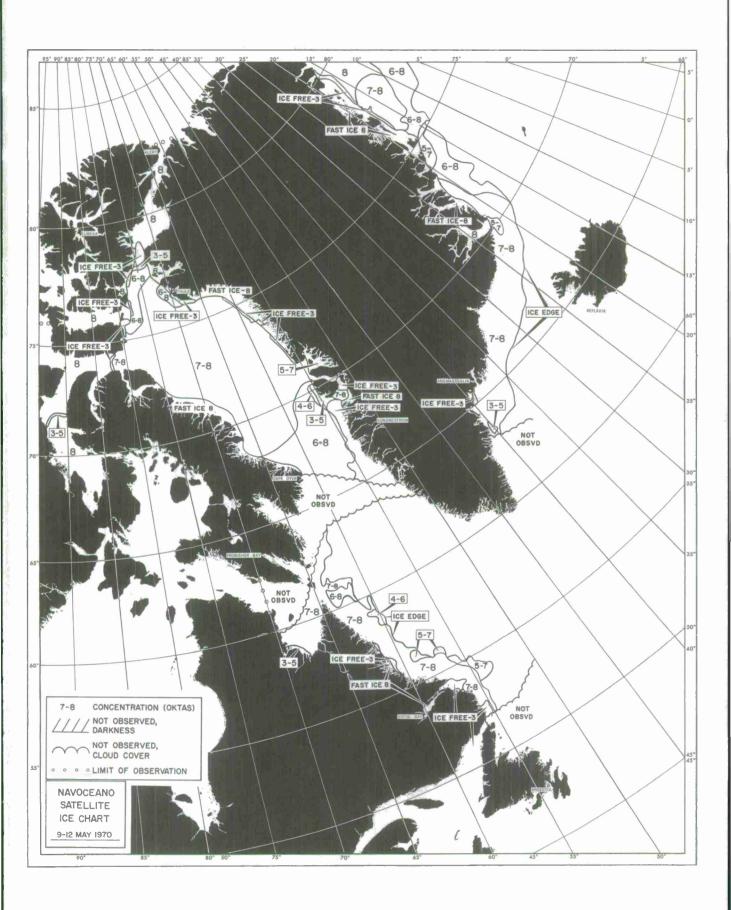


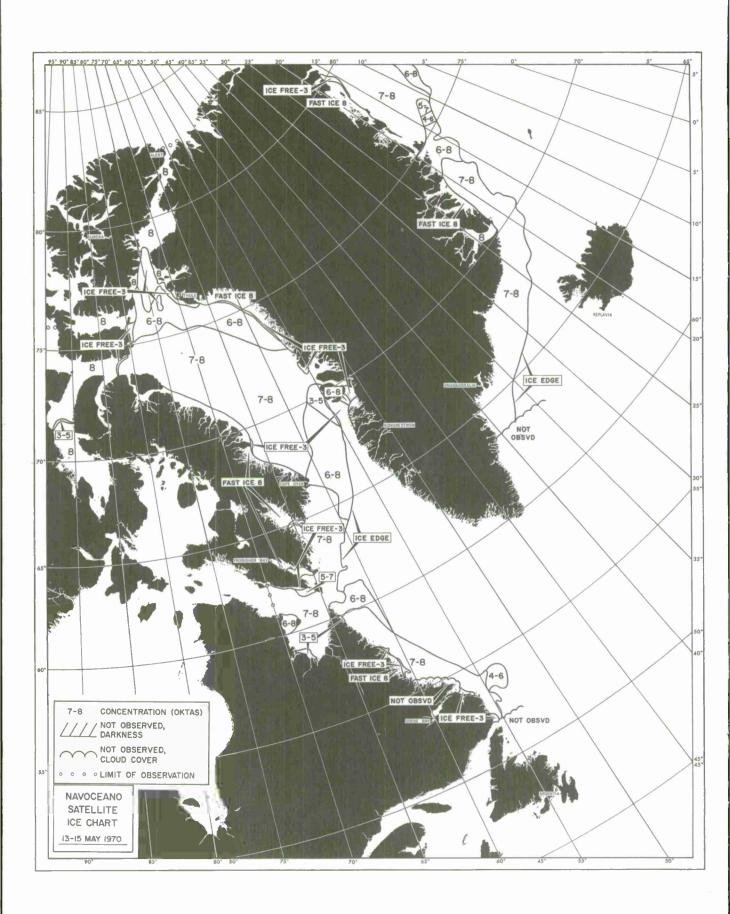


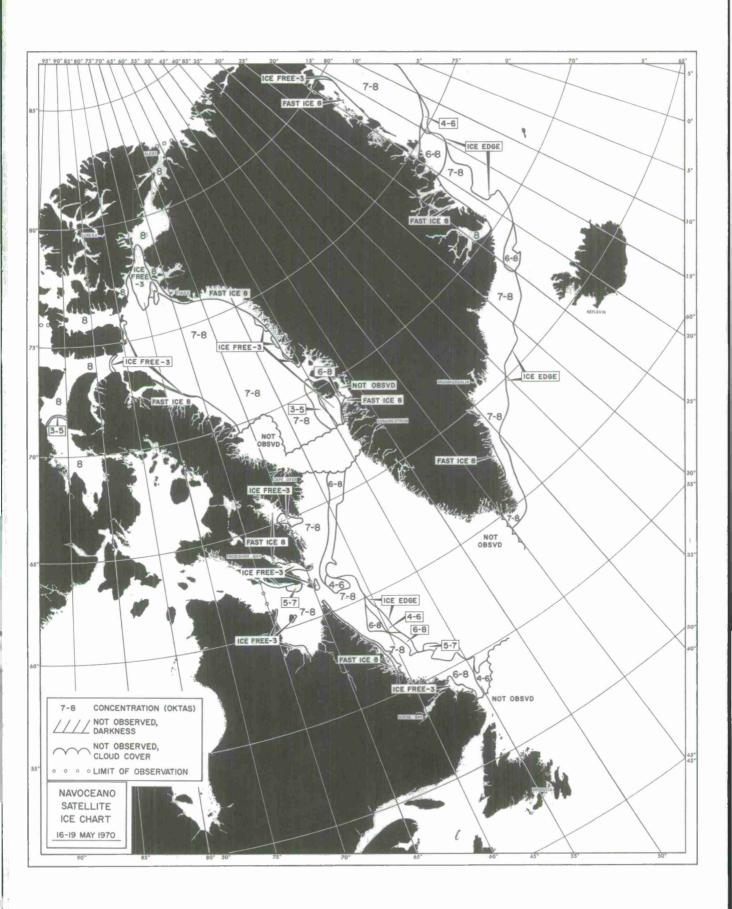


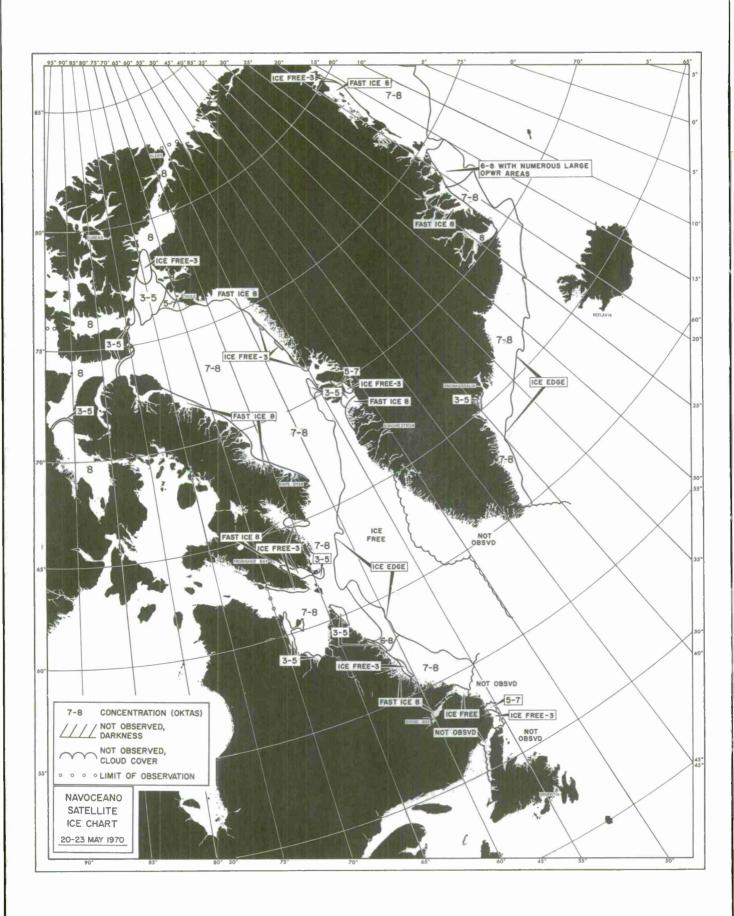


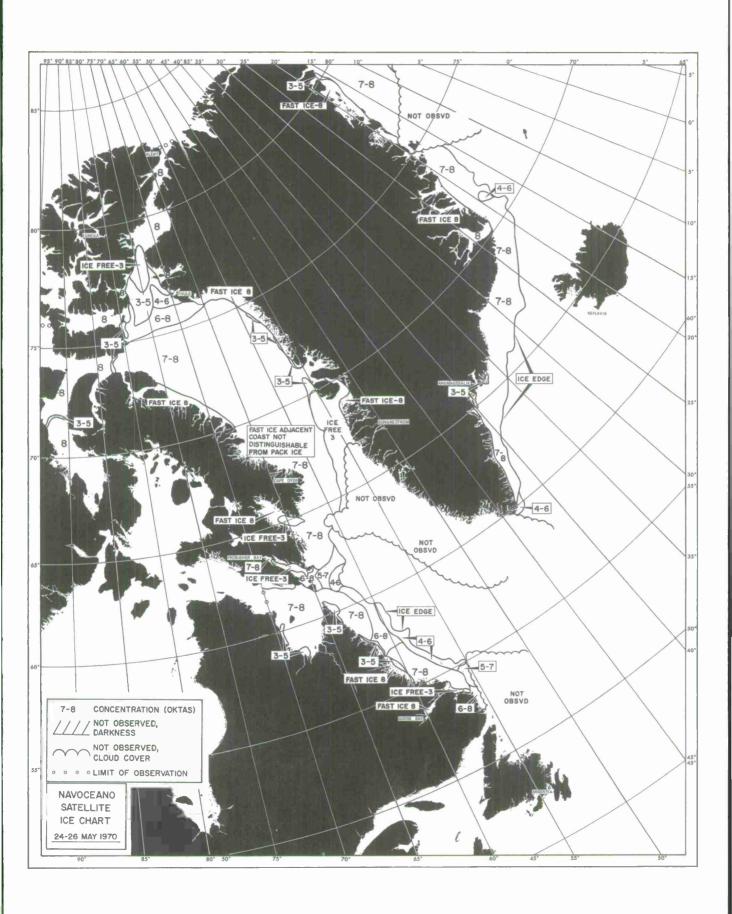


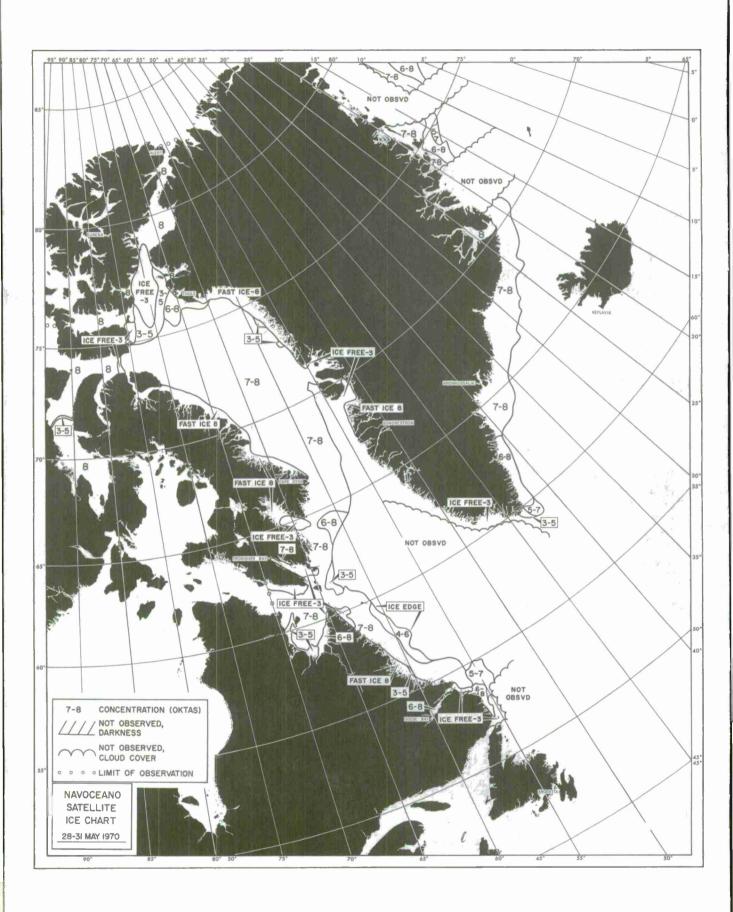


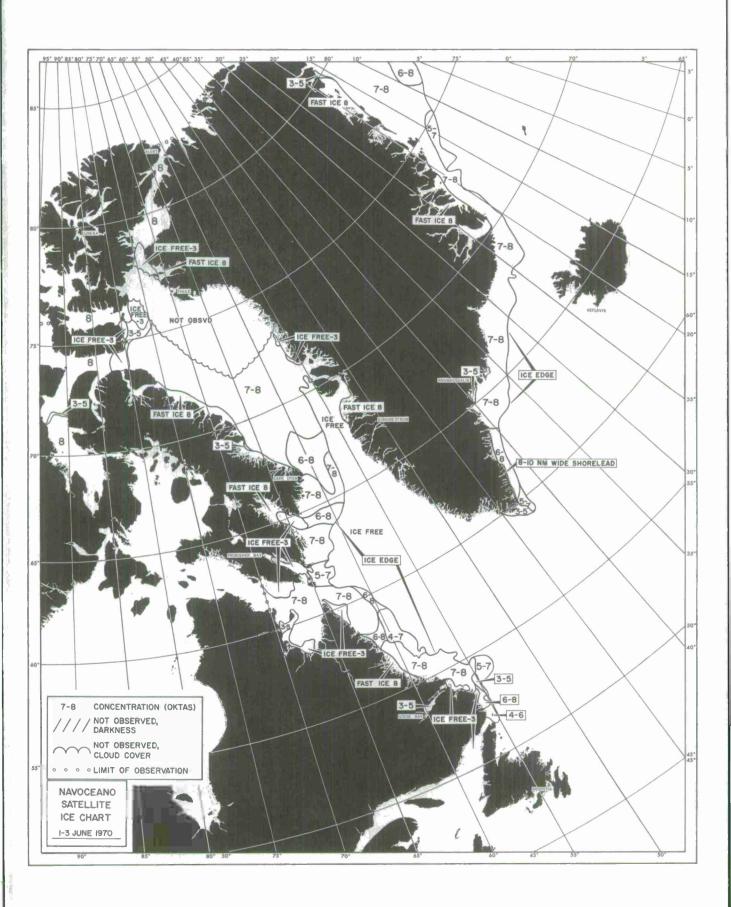


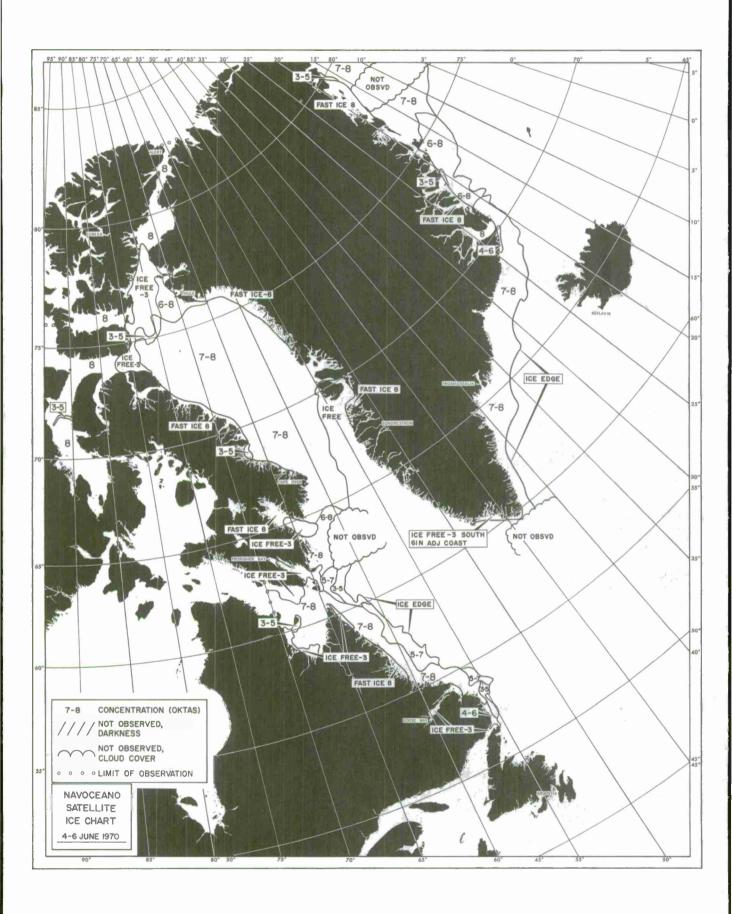


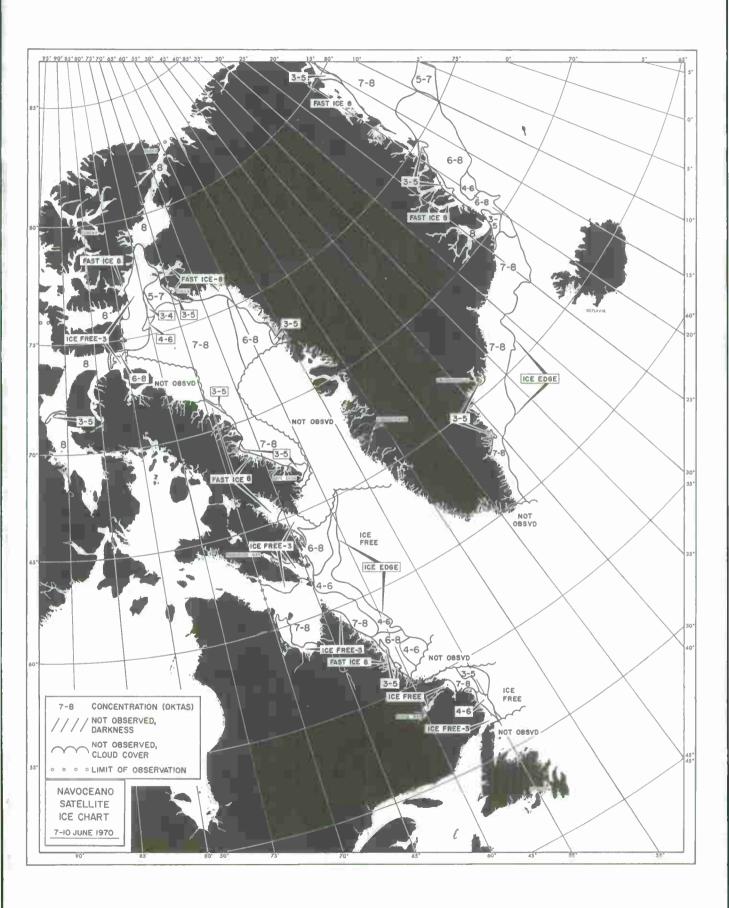


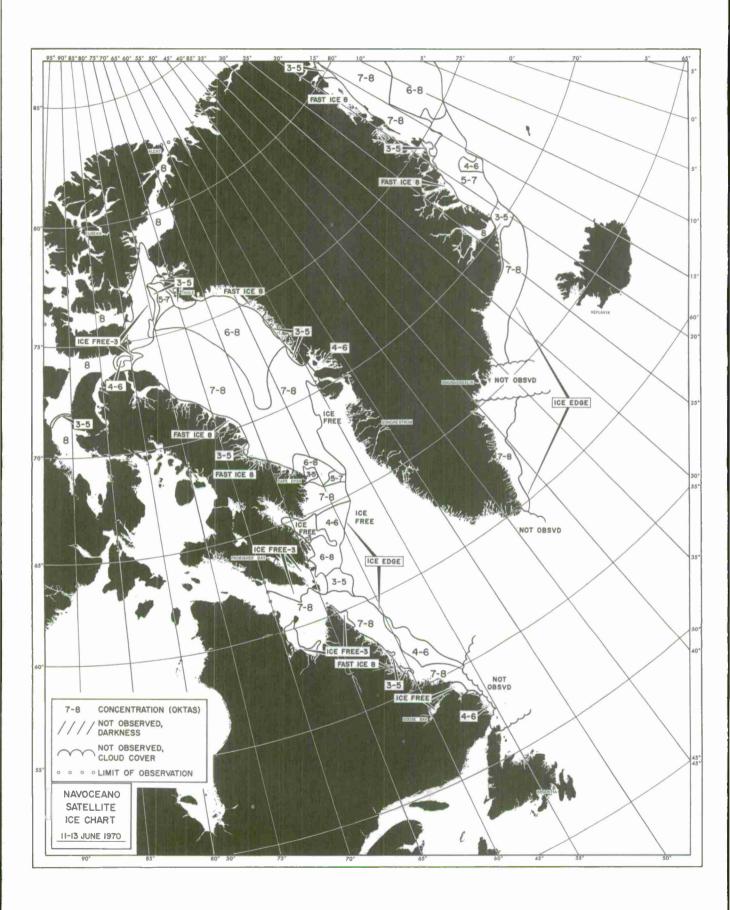


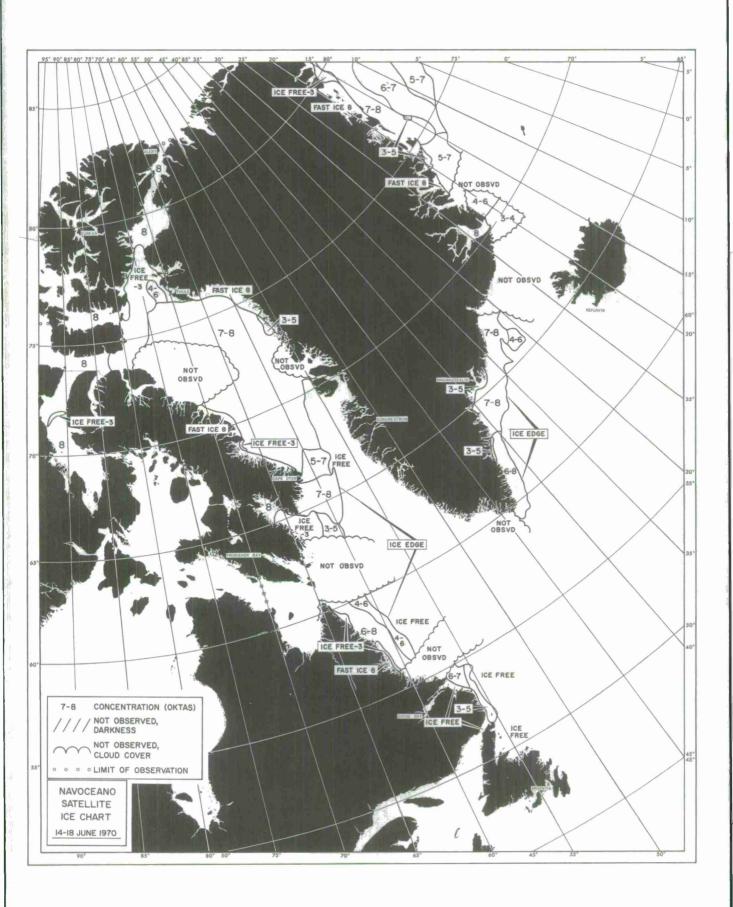


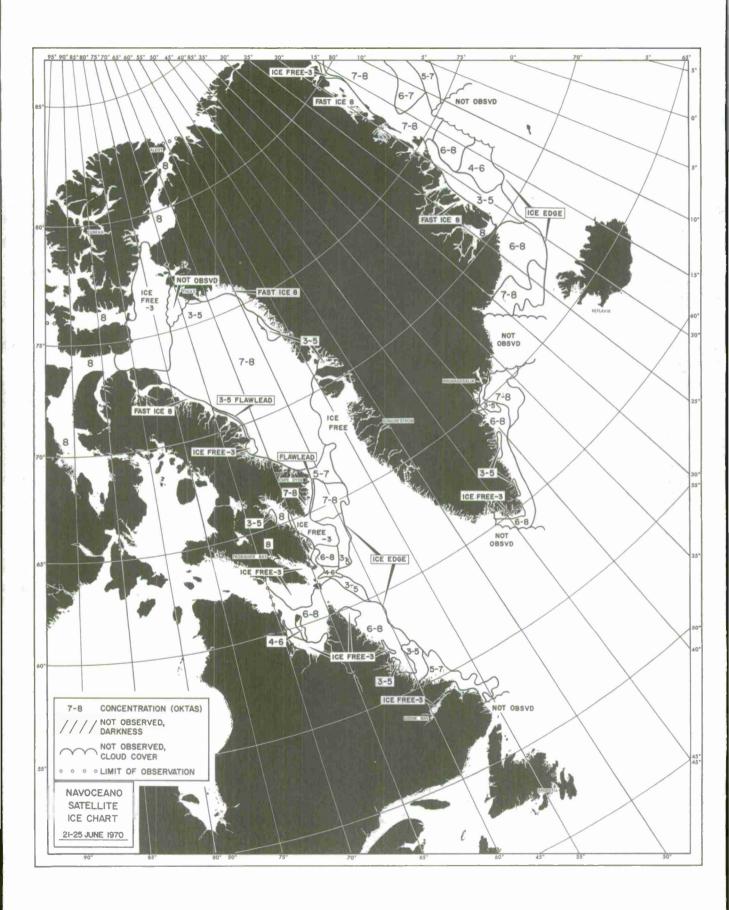


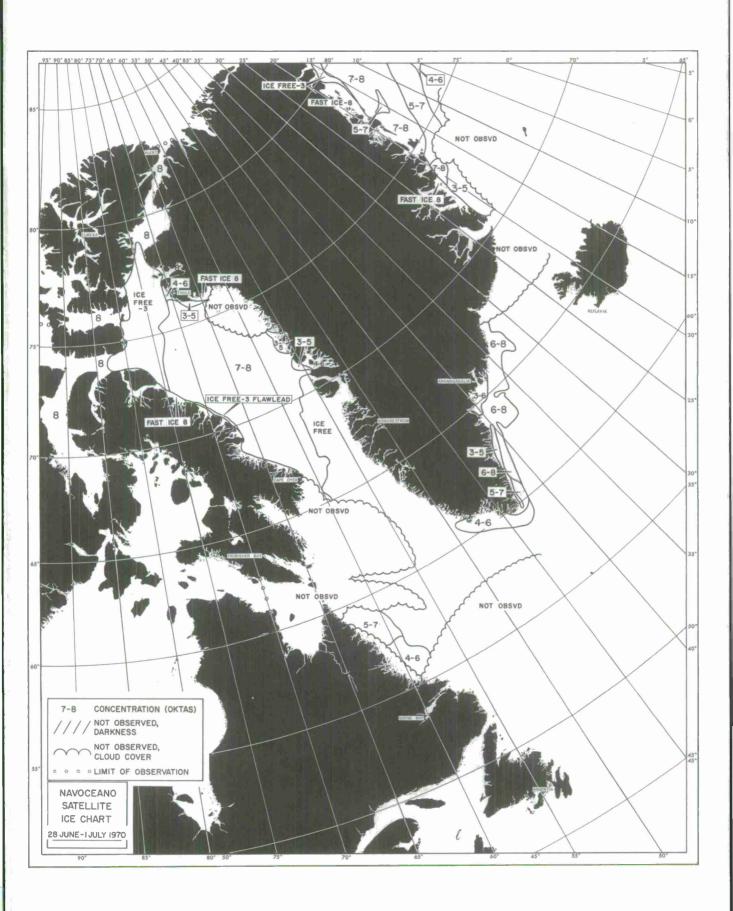


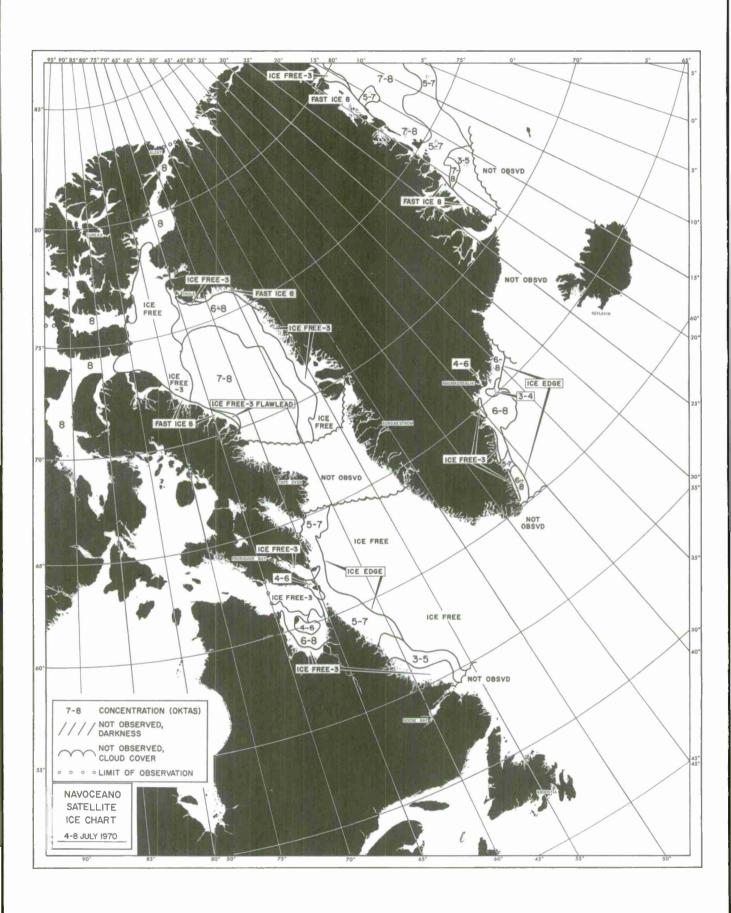


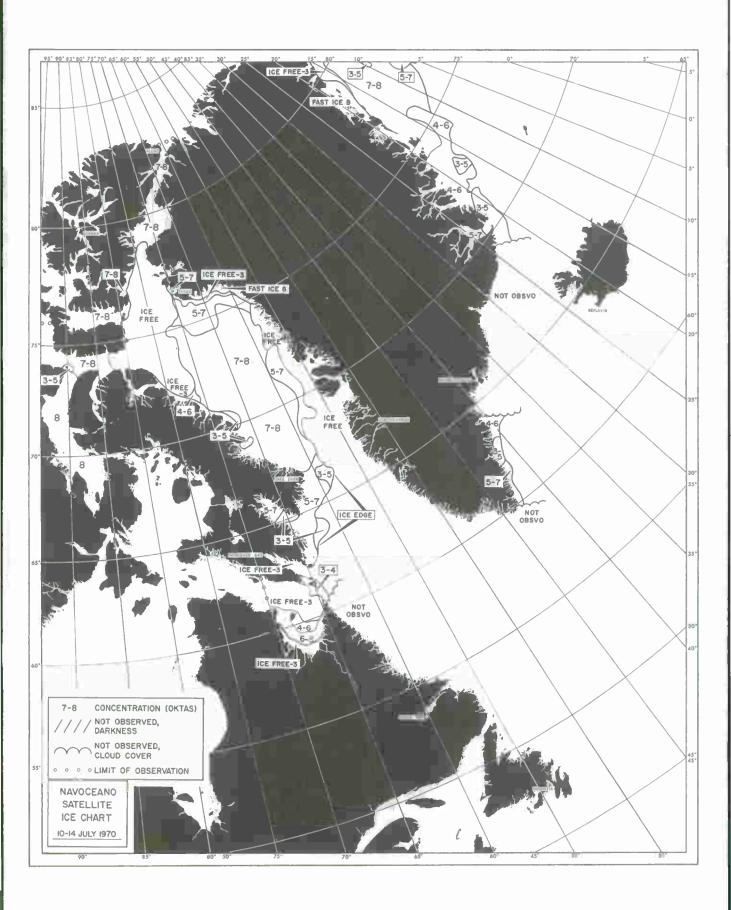


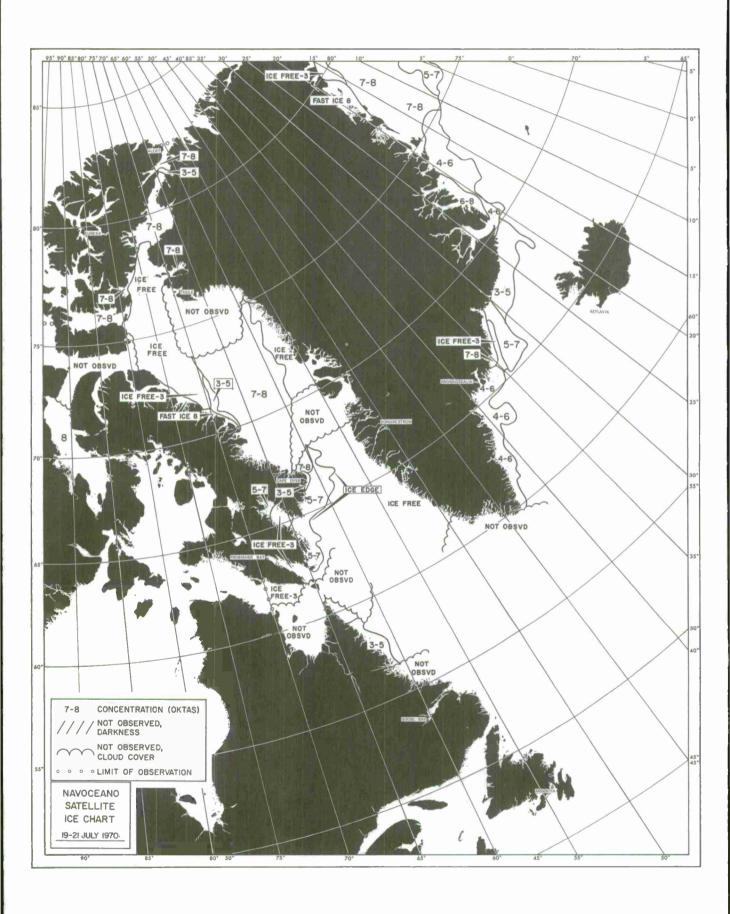


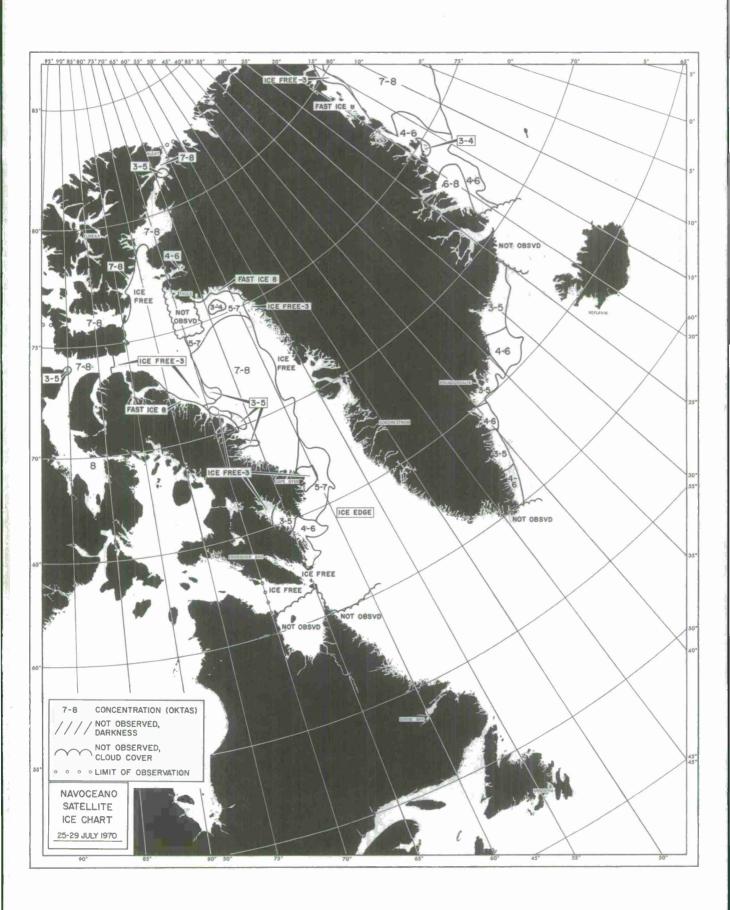


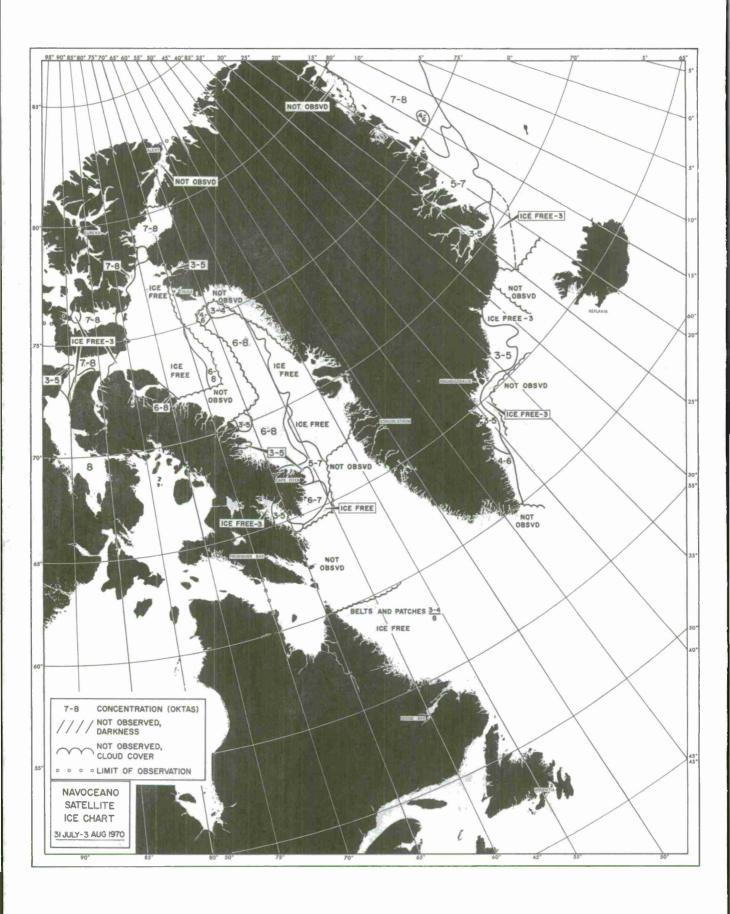


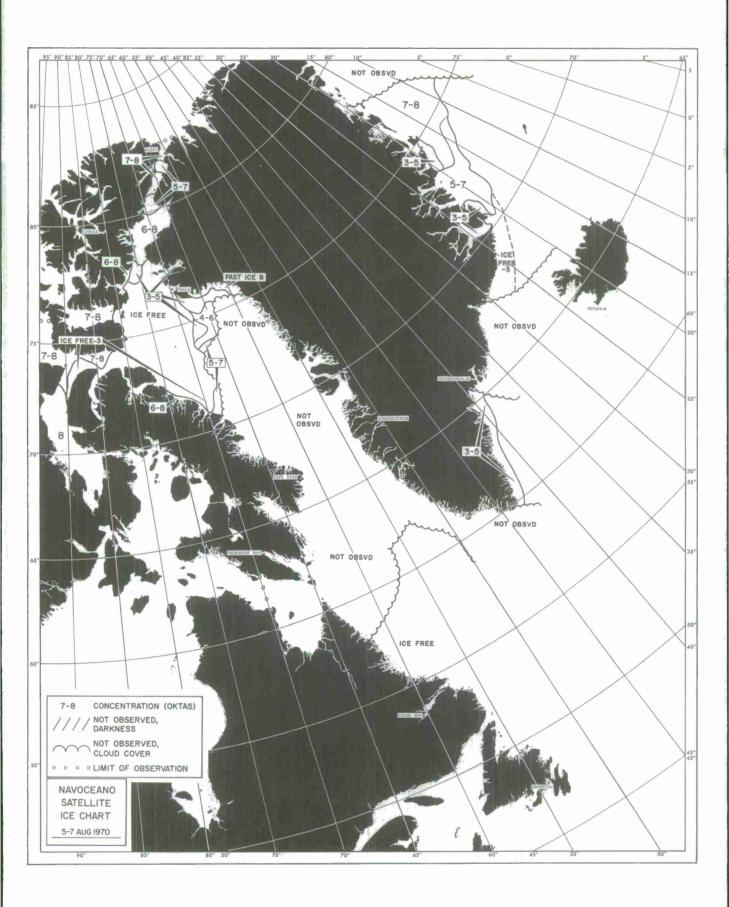


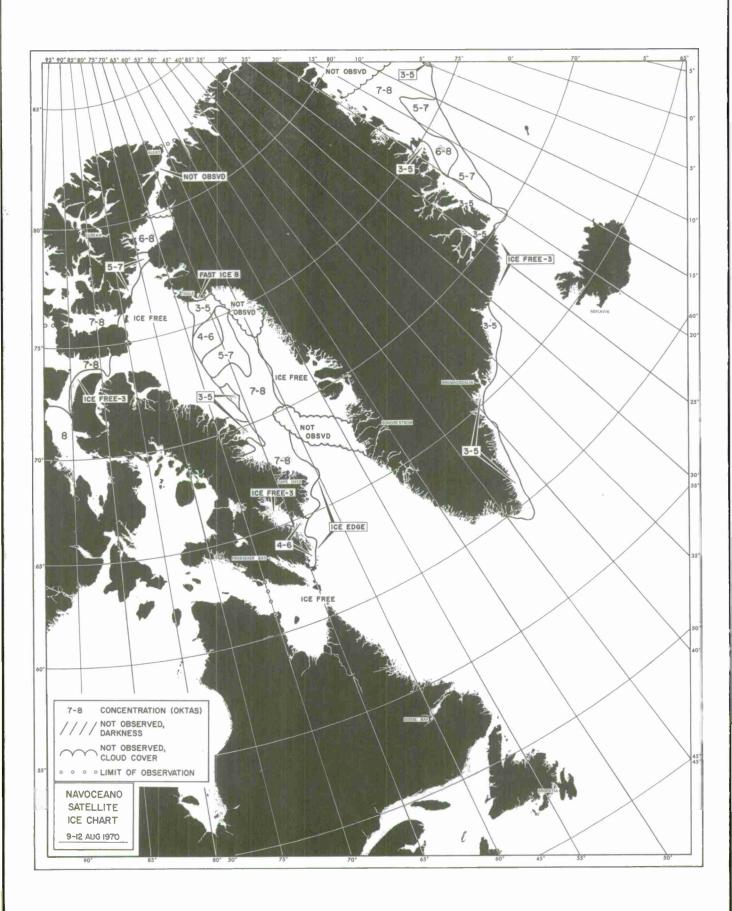


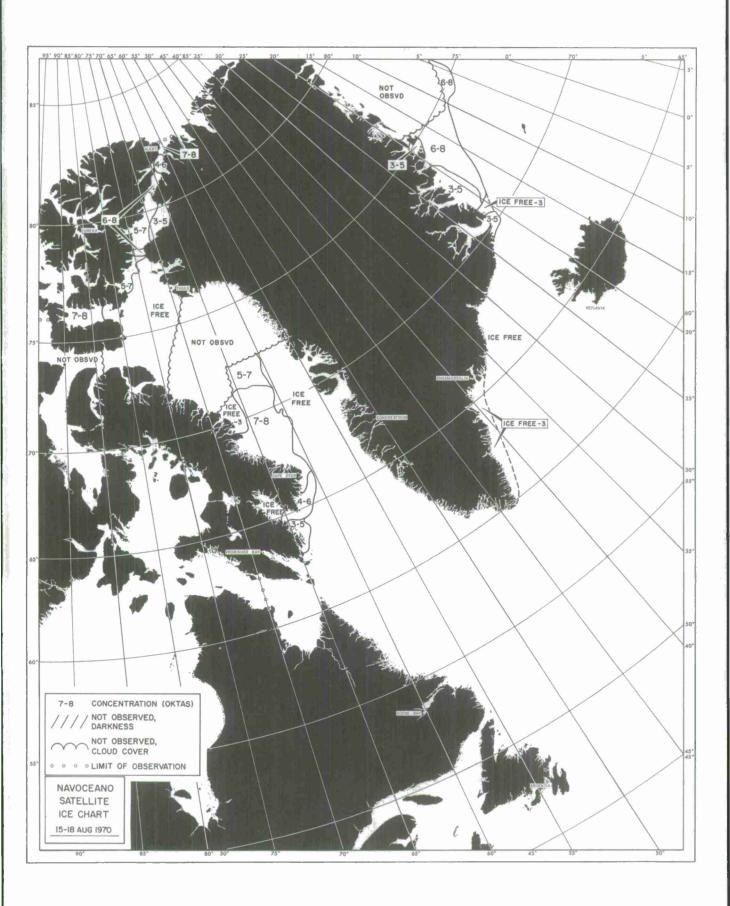


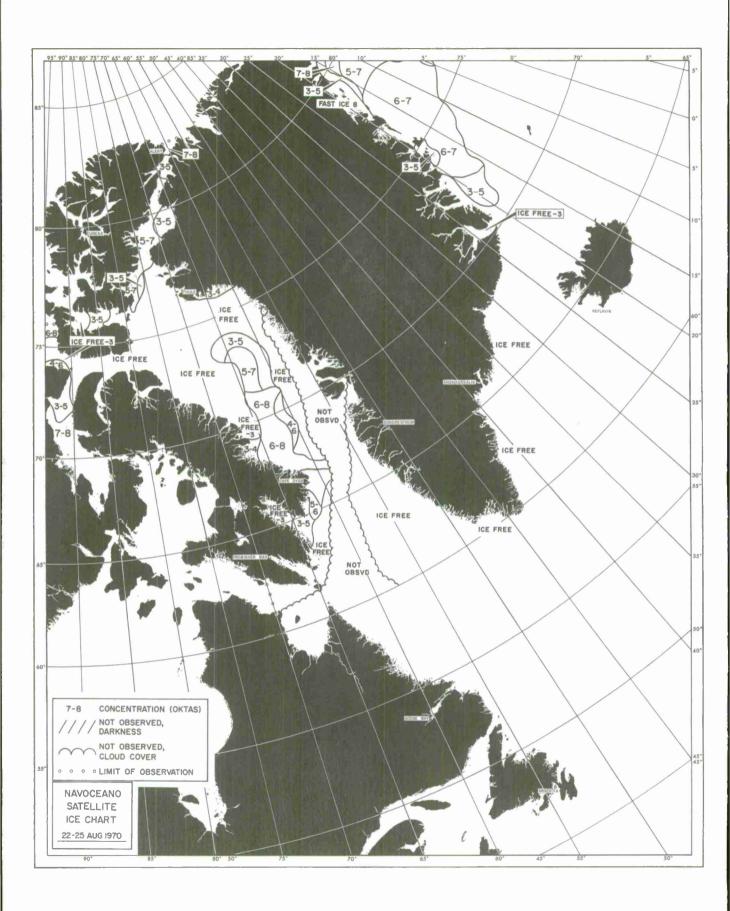


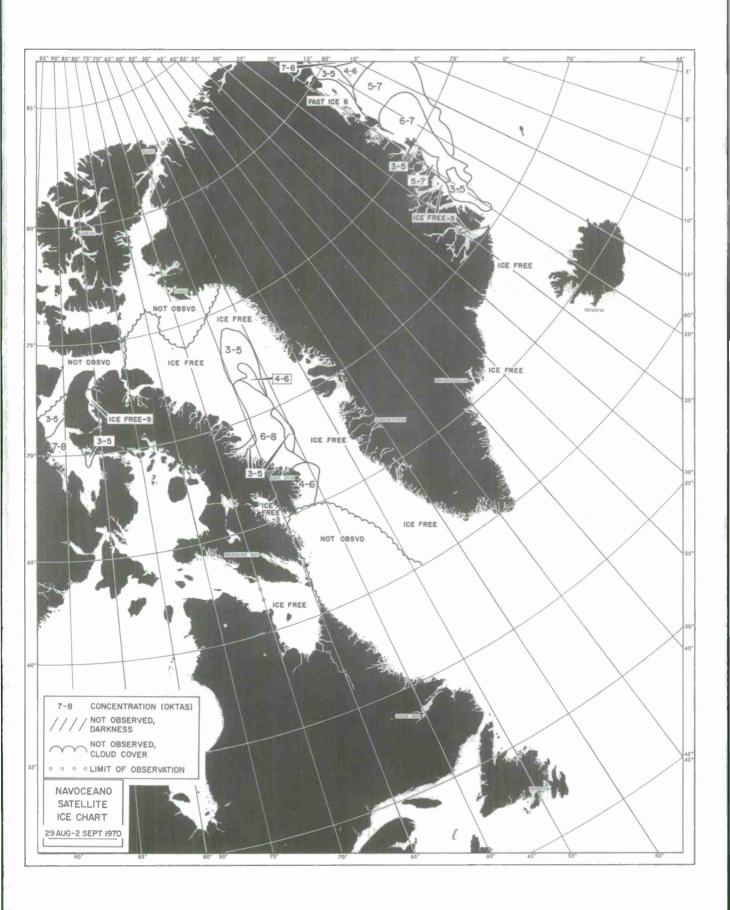




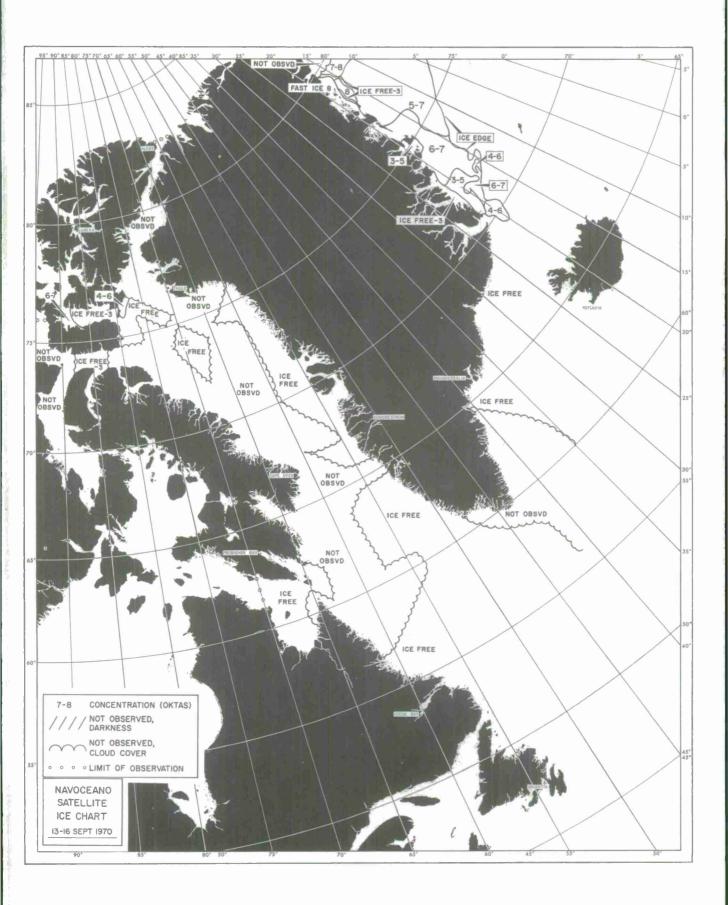


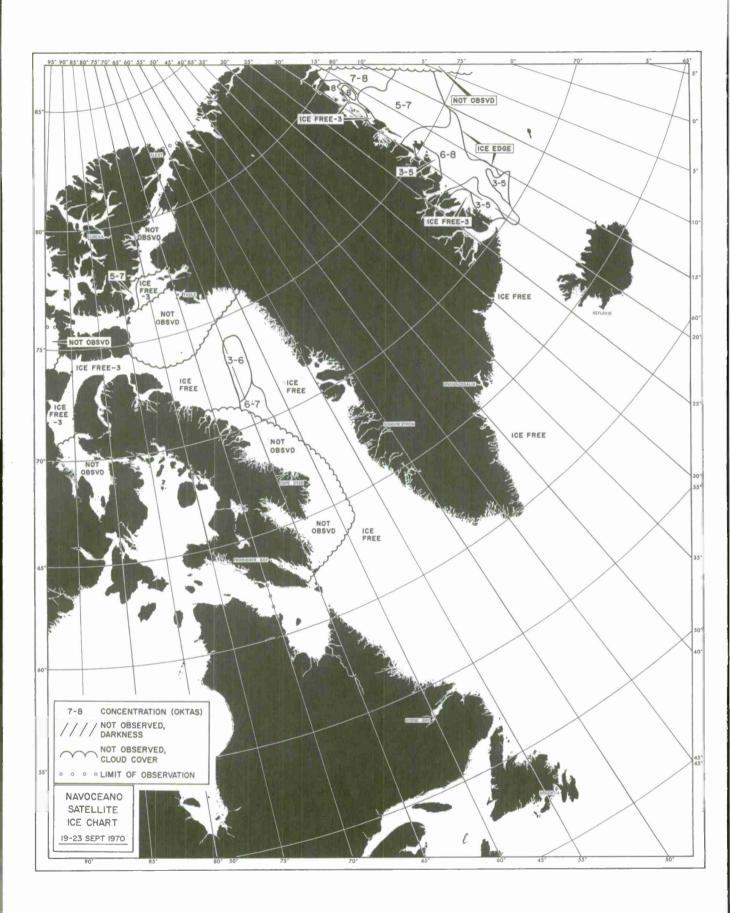


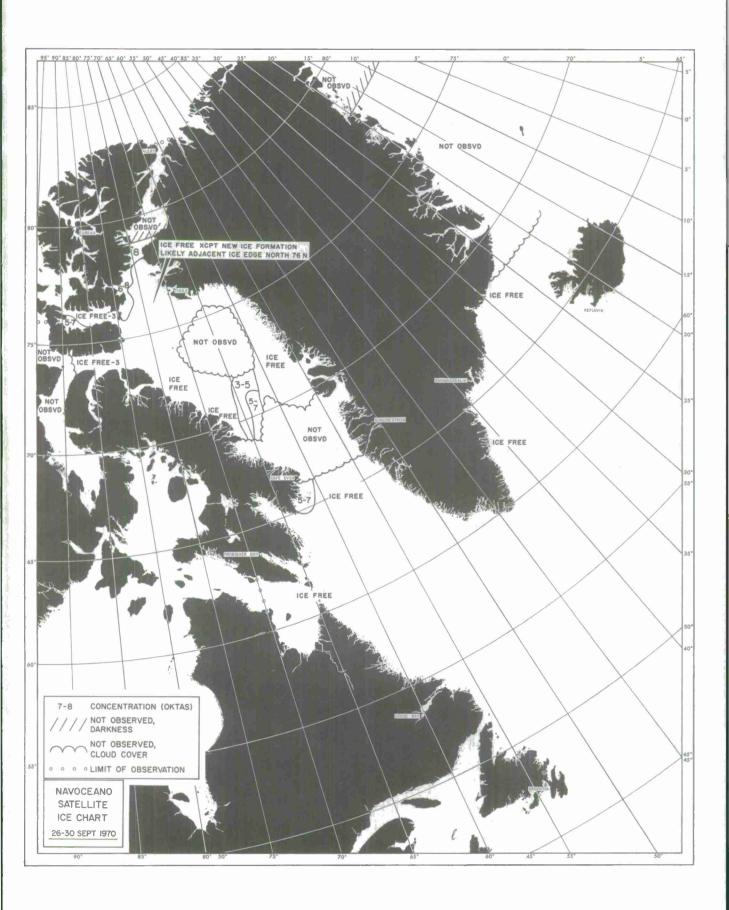










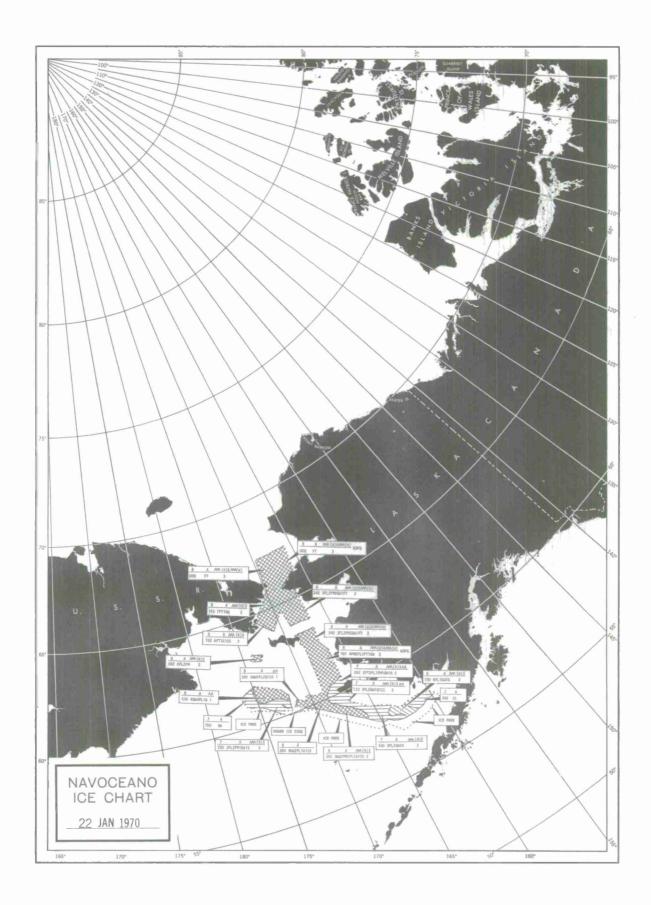


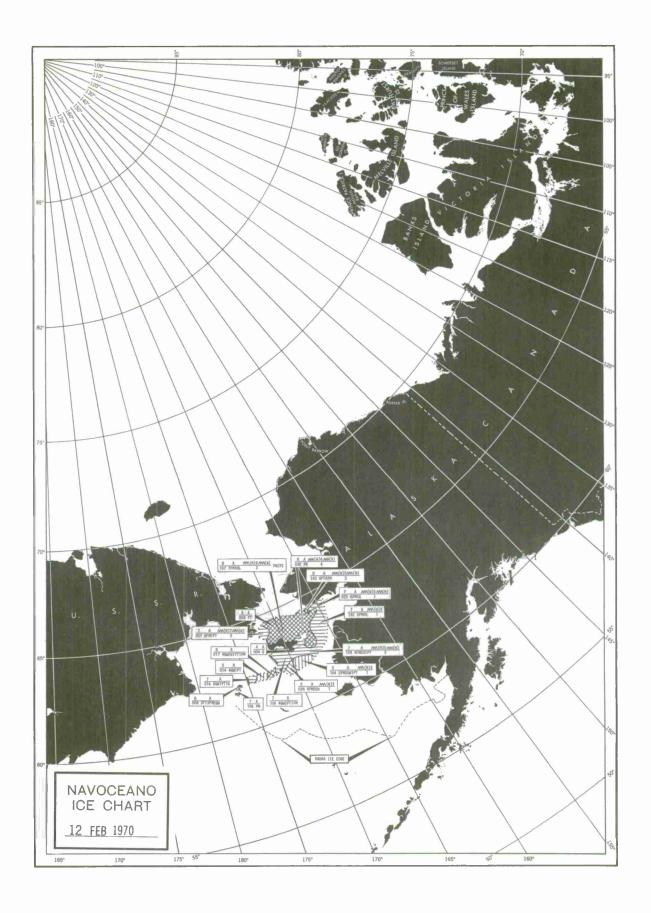


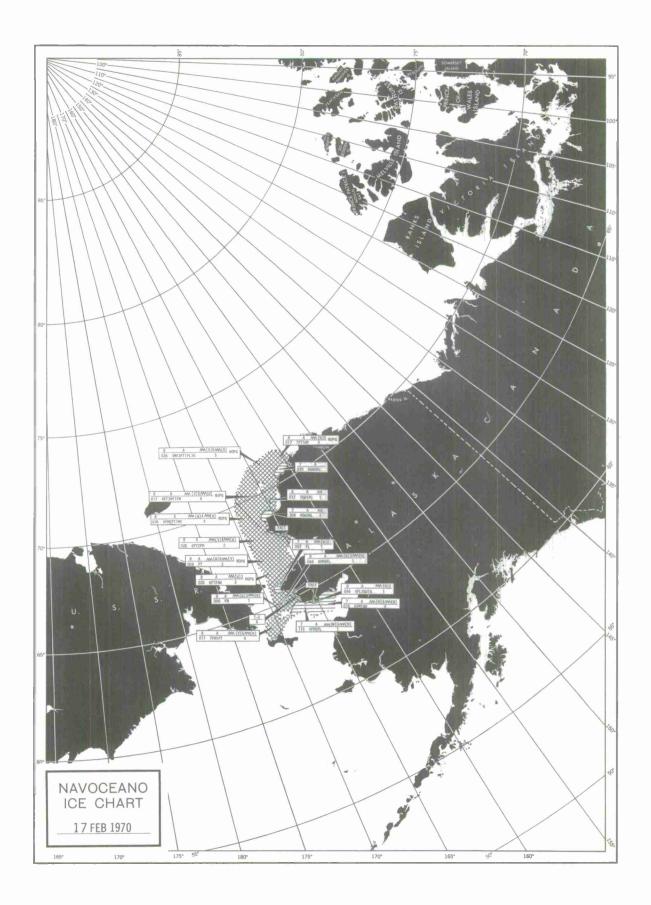
APPENDIX C WESTERN ARCTIC ICE CHARTS OBSERVED BY AERIAL RECONNAISSANCE

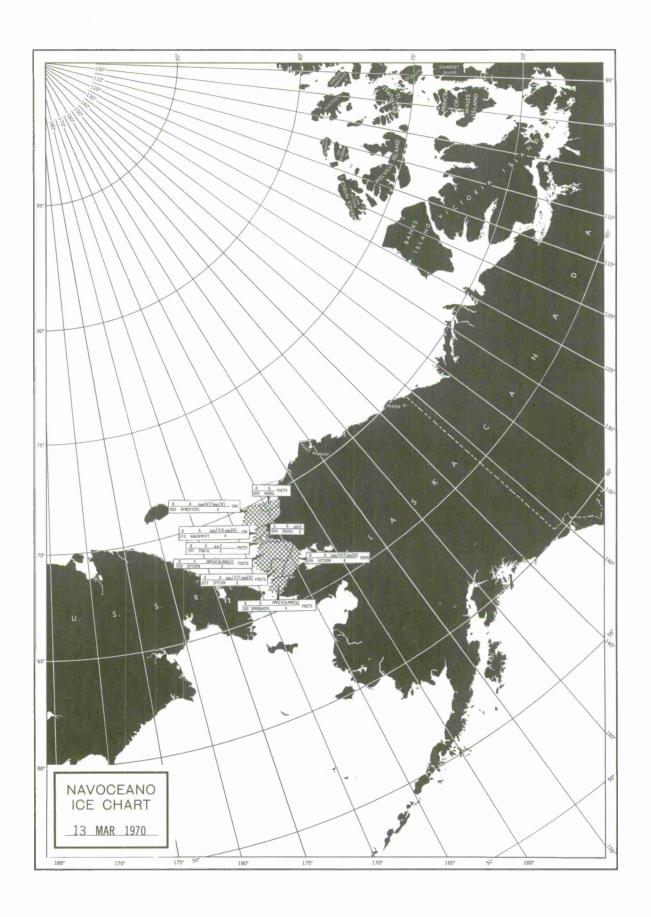
KEY TO ICE SYMBOLS USED IN PLOTTING ICE FEATURES

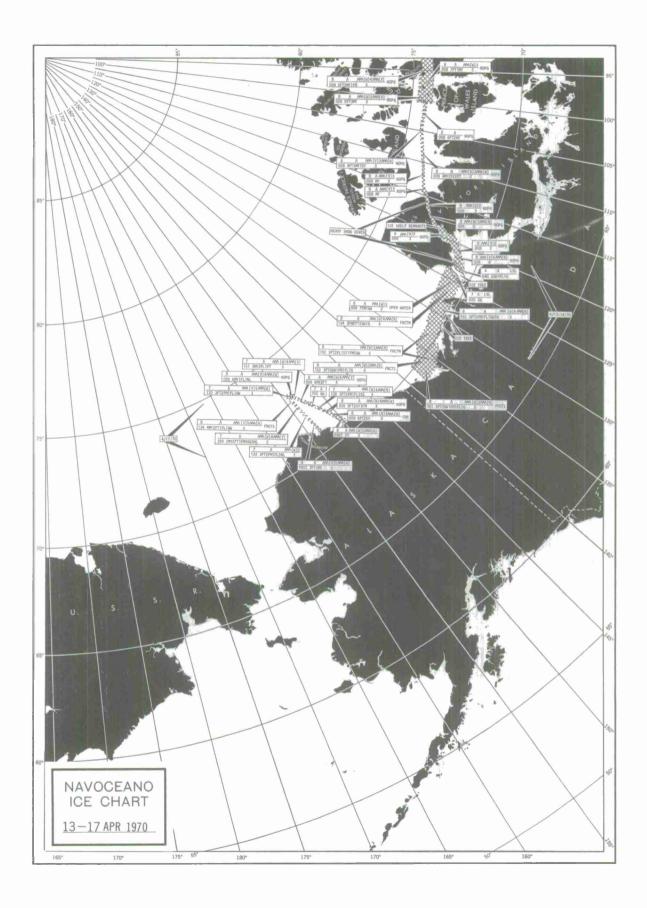
TOTAL CONCENTRATION **TOPOGRAPHY** CONC = Concentration Ice free **OO** Hummocks CRK = Crack <1 okta* CRKS = Cracks **/**√\(N) New Ridges • (open water) FRCT = Fracture M(W) Weathered Ridges 1-<3 aktos FRCTV = Very Small Fracture (very open pack) M(V) Very Weothered Ridges FRCTS = Small Fracture 3-<6 oktas M(A) Aged Ridges FRCTM = Medium Fracture (open pack) M(C) Cansolidated Ridges FRCTL = Large Fracture √ 6-<7 oktas </p> LVL = Level Ice (close pack) **///** (N) (h) Example: NDTR = Not Determined 7-<8 oktas NOPG = No Openings in Ice (very close pack) (h) height of ridges in meters OPWR = Open Water 8 oktas (n) tenths caverage an ice SCTD = Scattered (compact pack) = Snow Depth SD STAGE OF MELTING T = Ice Thickness COVERAGE BY SIZE FPD = Few Puddles C MPD = Many Puddles n1n2n3 FTH = Few Thaw Holes C = total cancentration MTH = Many Thow Hales SS/NL = New Ice or Nilas DRI = Dried Ice ROT = Ratten Ice n_1 PK = Poncake < 3 m FLO = Flagded Ice CK = Brosh, Small Cake, Coke < 20 m SF = Smoll Floe 20-100 m m2 MF = Medium Floe 100—500 m **UNDERCAST** BF = Big Floe 500-2000 m CCC Limit VF = Vast Floe 2-10 km ⁿ3 GF = Giant Flae > 10 km Fast = Fast Ice THICKNESS OF ICE & SNOW Example: 7 = tatal concentration 7 1 = okto all pancake ice t_F = ice thickness in cm 124 2 = aktas small and medium ice floes s = snaw depth in cm PK 4 = aktas blg, vast, and giant ice floes STAGE OF DEVELOPMENT PHENOMENA A ***** crock aktas predaminant, aktas secandary AVERAGE THICKNESS fracture AGE SS = Frazil, Grease, Slush, Shuga palynyo NL = Ice Rind, Dark Nilas, Light Nilas — -<5-10 cm > leod ____ 10-15 cm G = Grav GW = Groy-White _ _ _ _ _ _ 15-30 cm (n) icebergs FL = Thin First-Year ---- 30-70 cm (n) bergy bits & growlers FM = Medium First-Year --- - 70-120 cm ---->120 cm FT = Thick First-Year (n) = number in area SY = Second-Year MY = Multi-Year ICE EDGE Example: A _____ abserved 5FM3G ---- radar A = Stage of development 5FM = 5 oktas Medium First-Year • • • • • limit af 3G = 3 oktos Gray abserved data *One akta equals one-eighth ice cancentration • — • — • satellite data

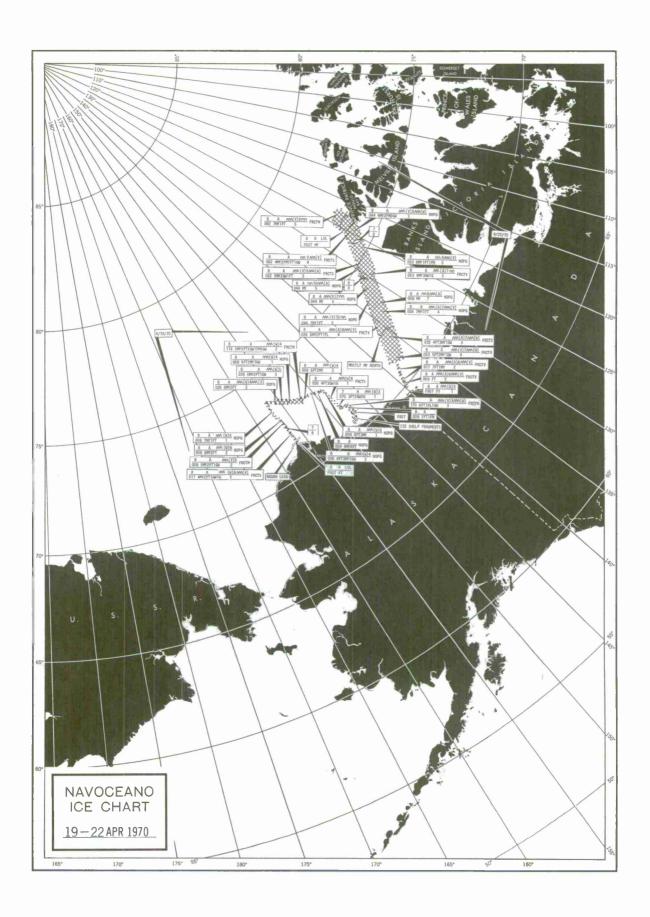


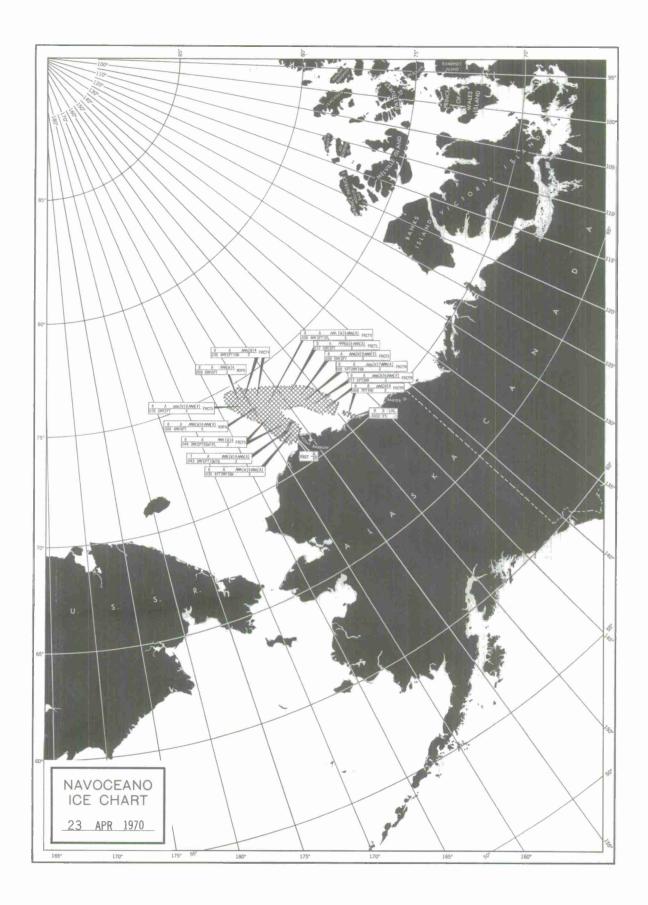


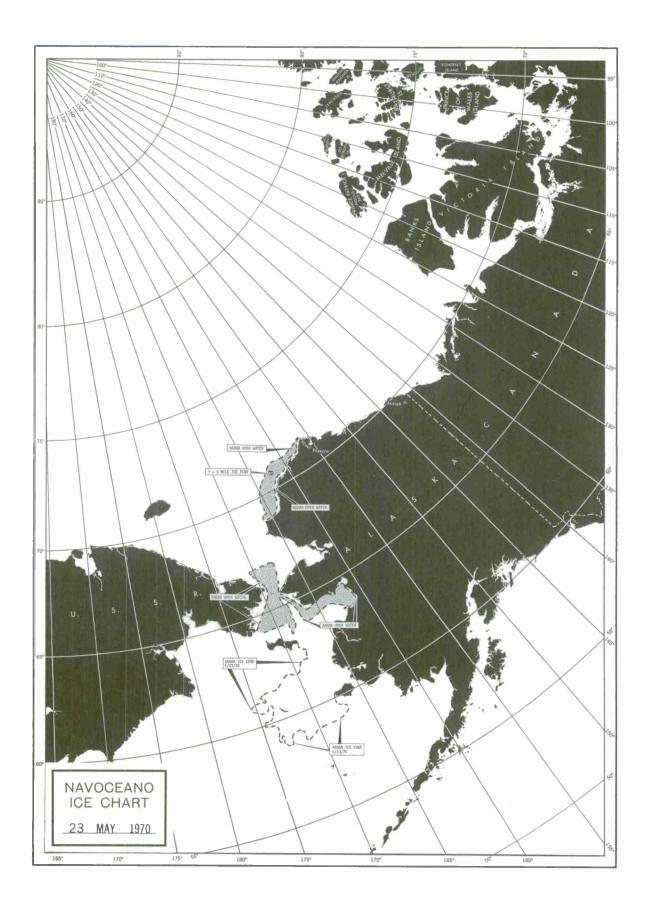


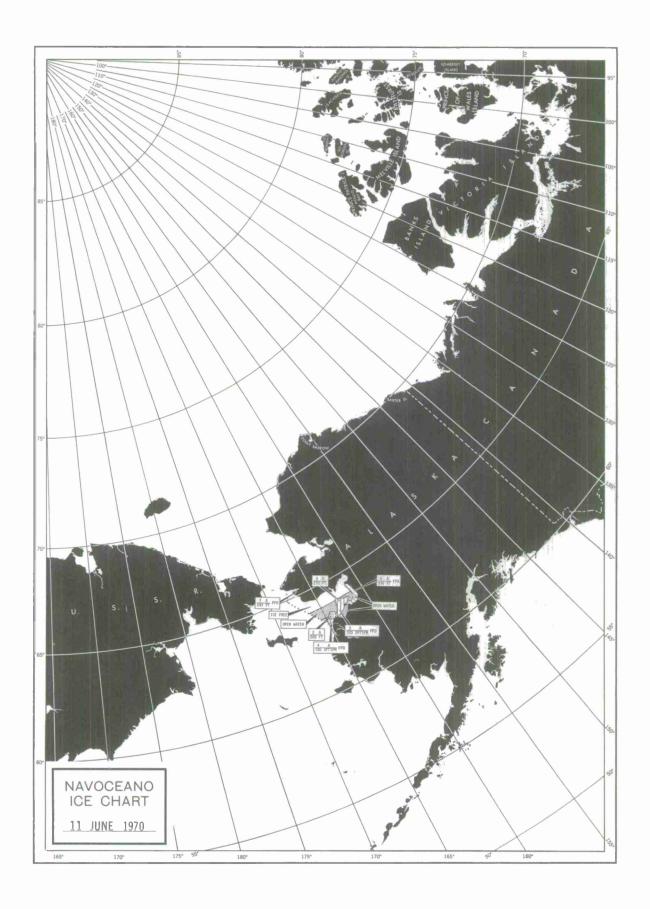


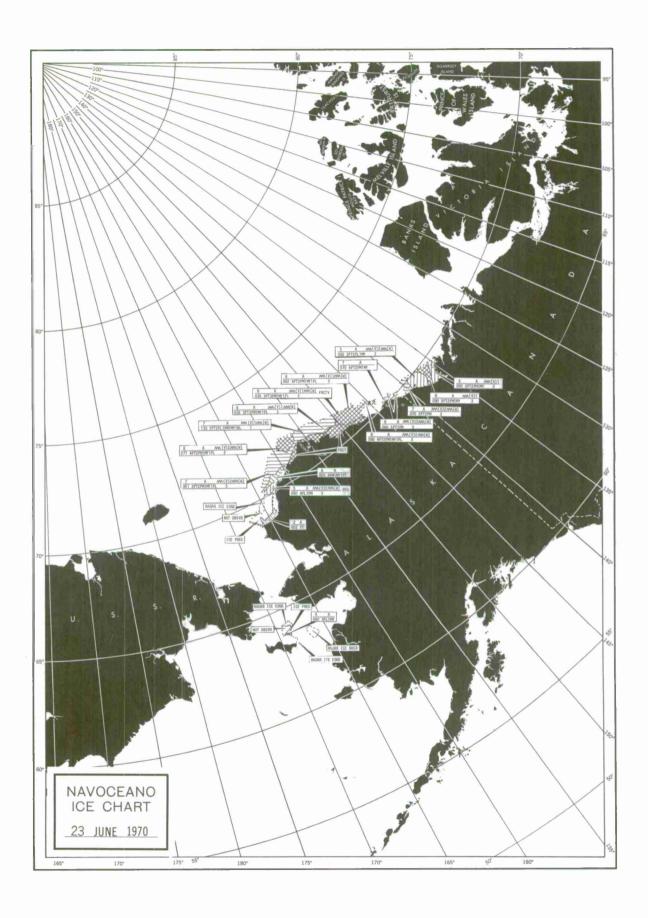


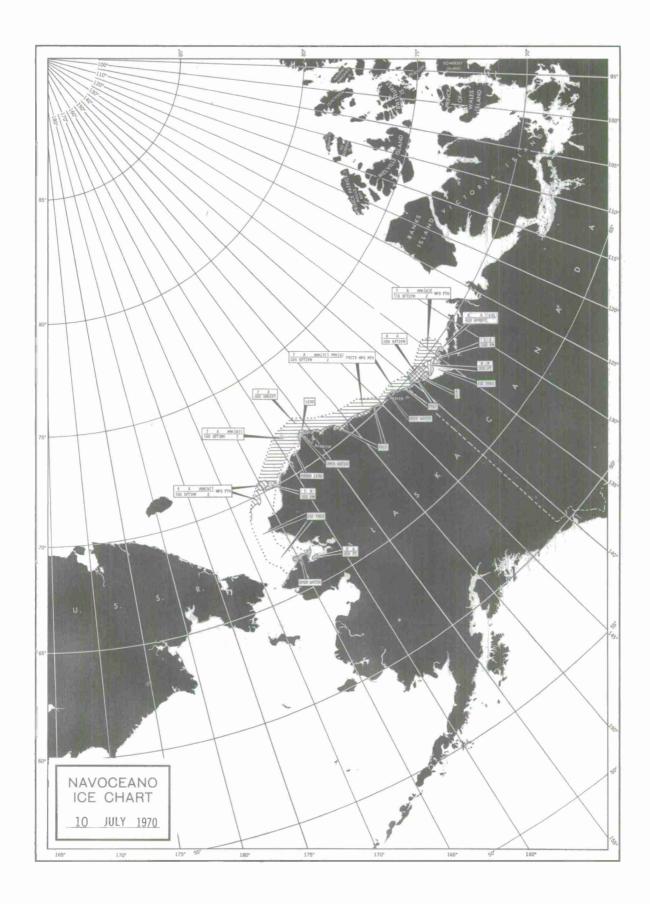




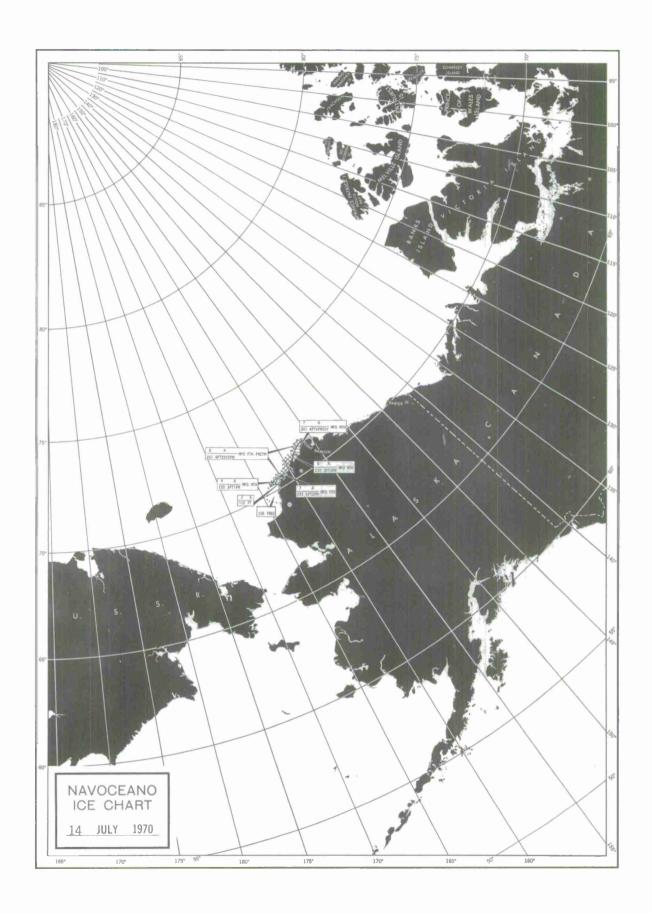


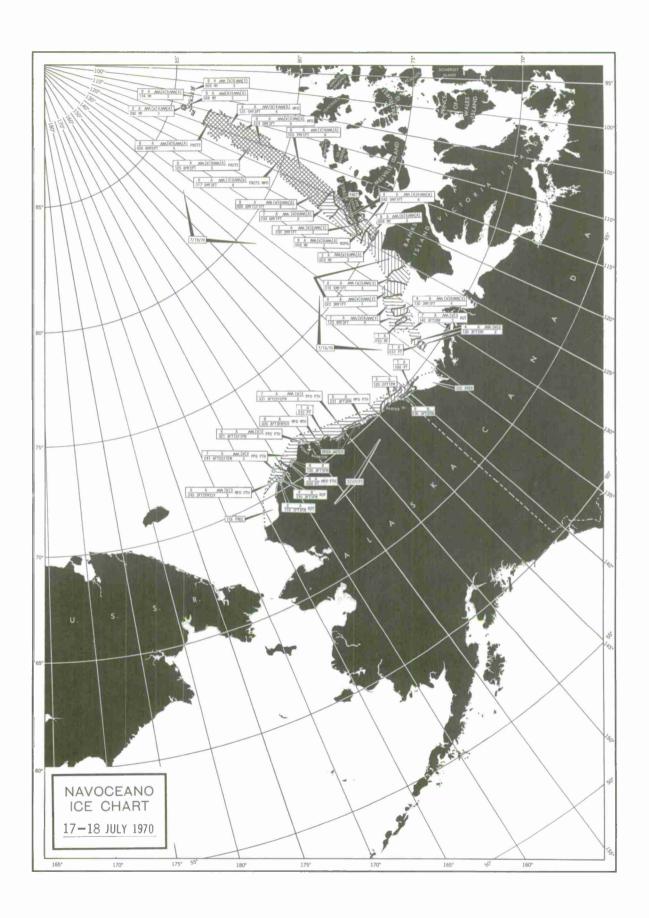


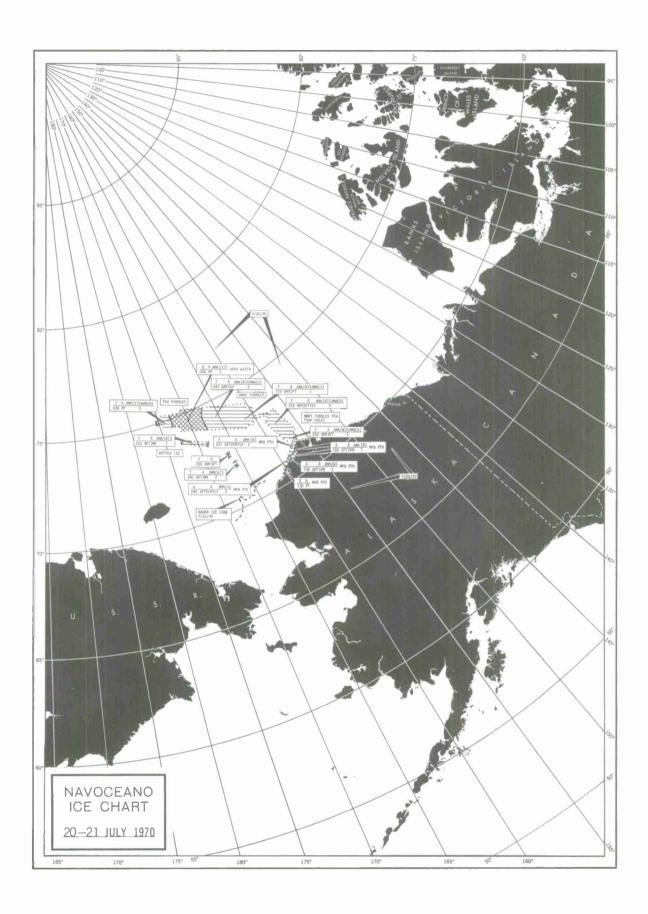


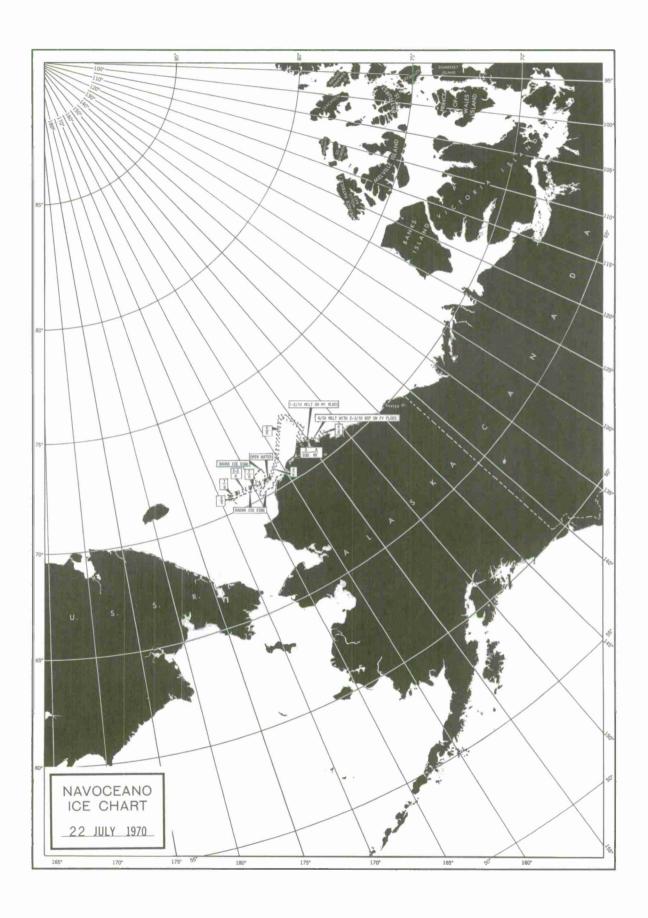


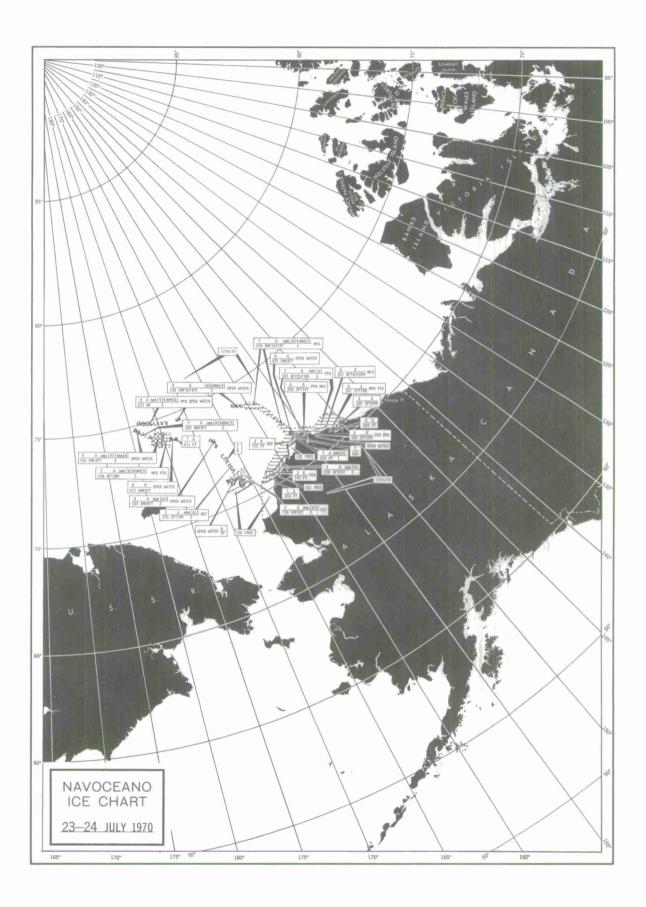


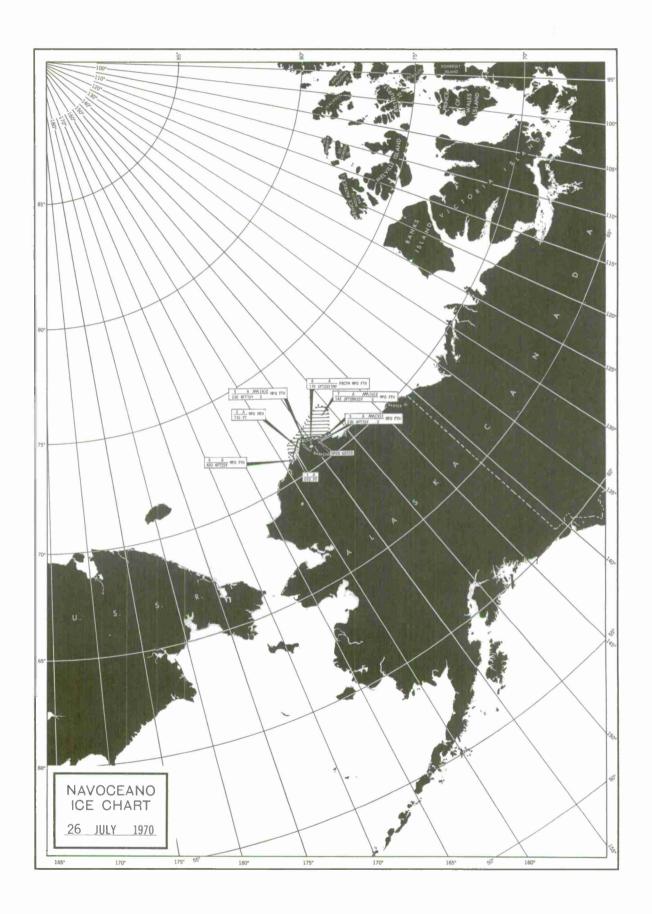


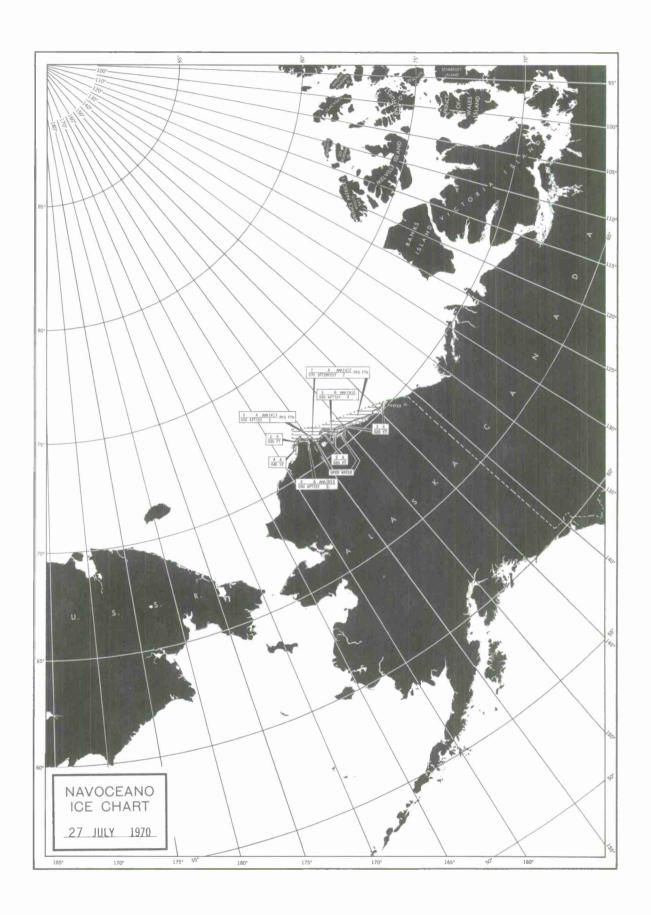


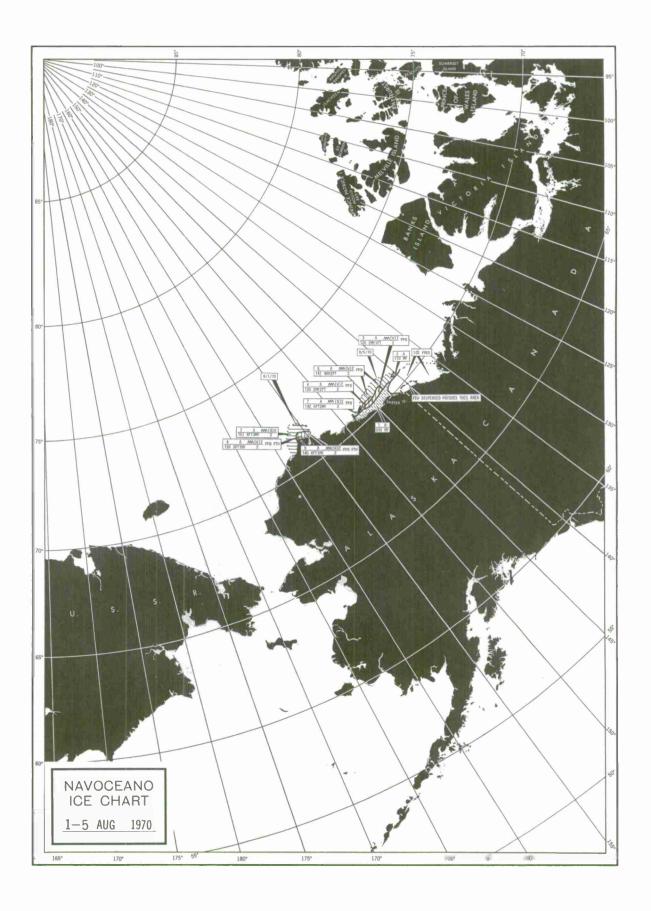


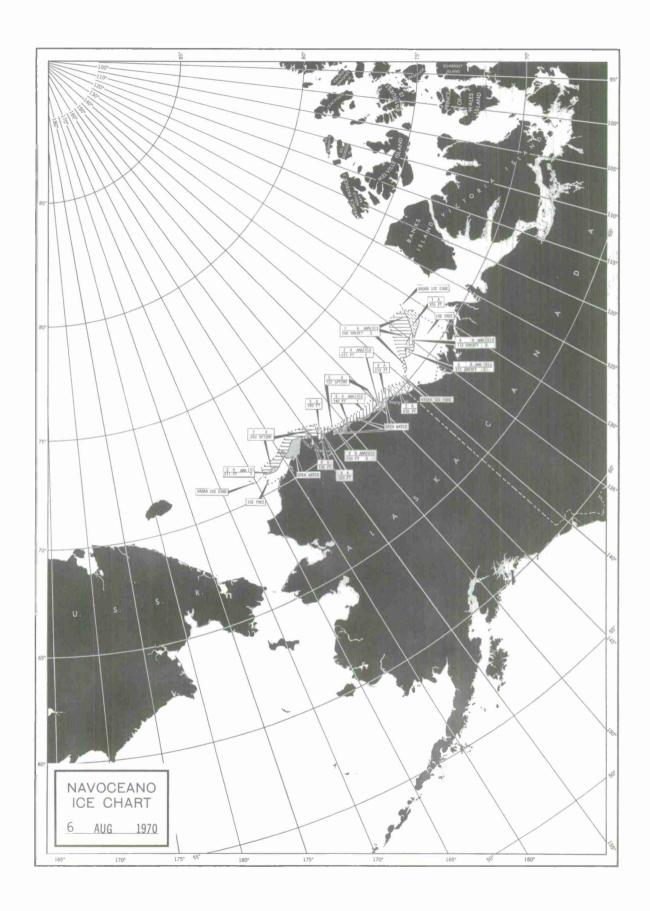


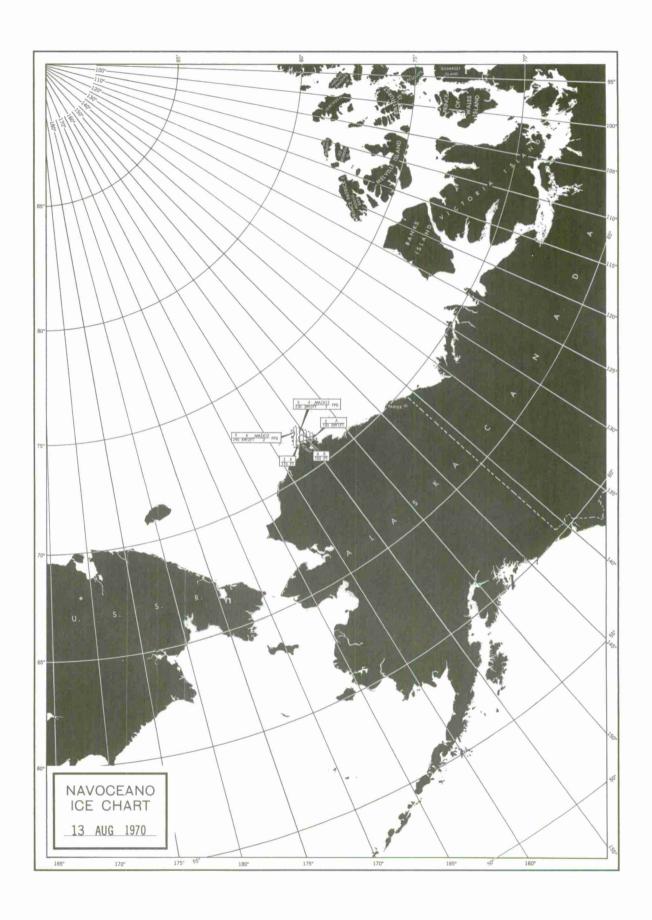


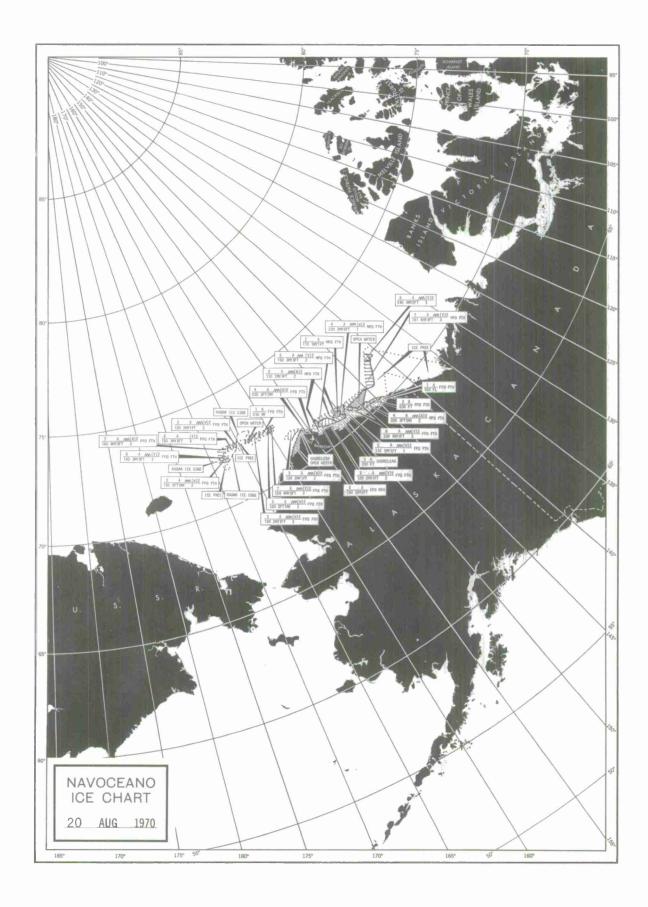


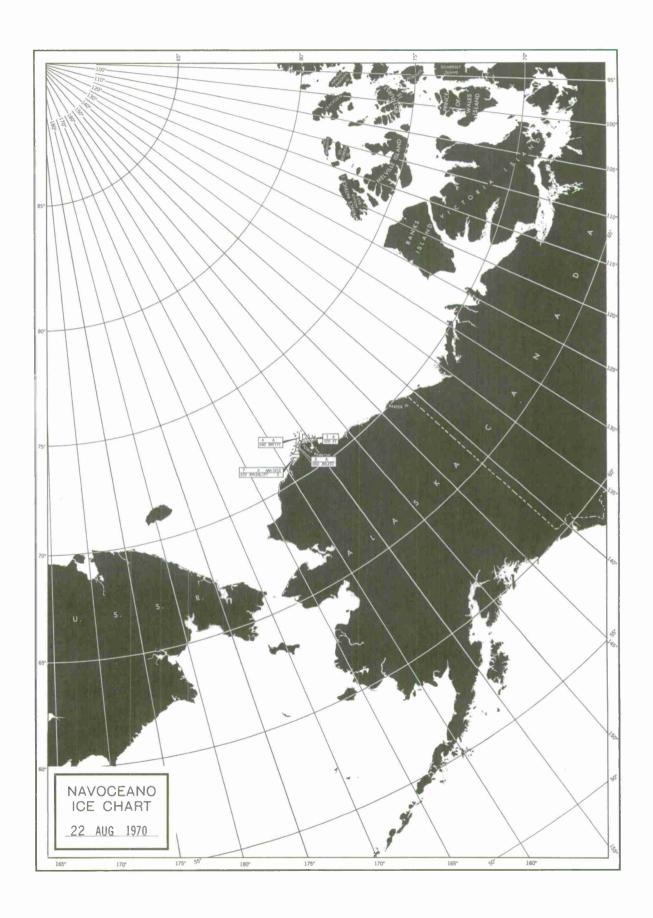


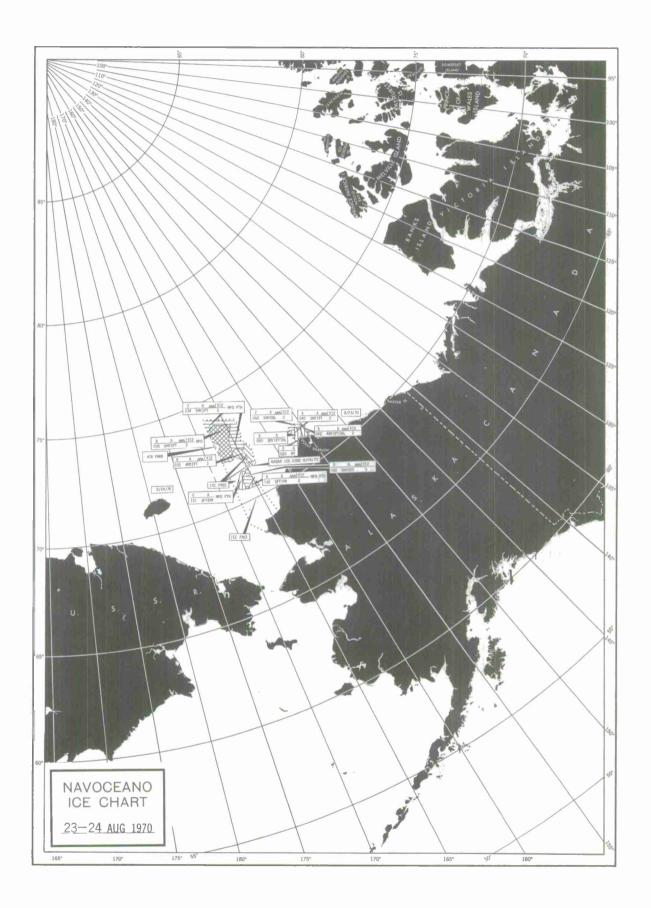


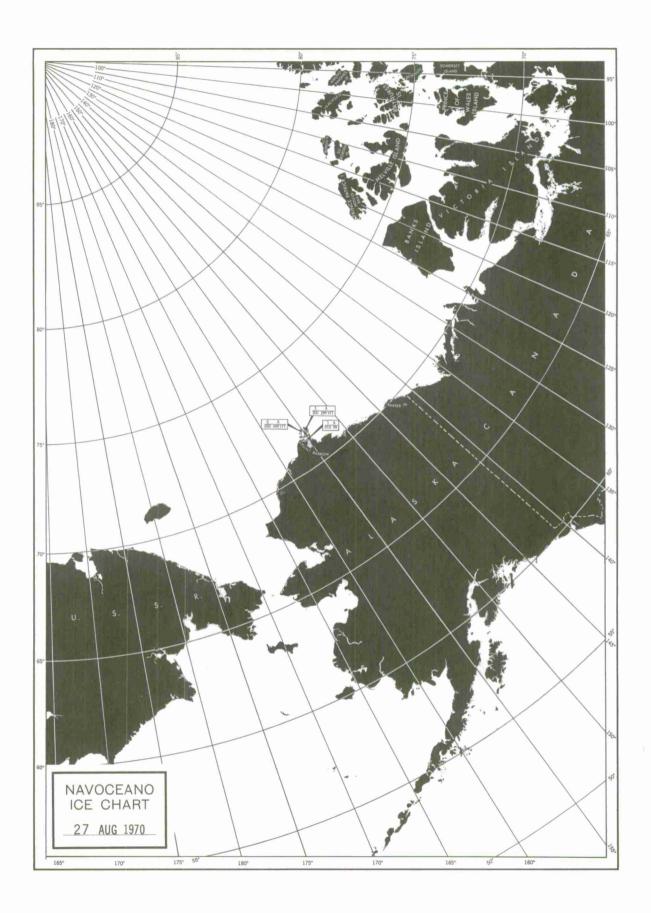


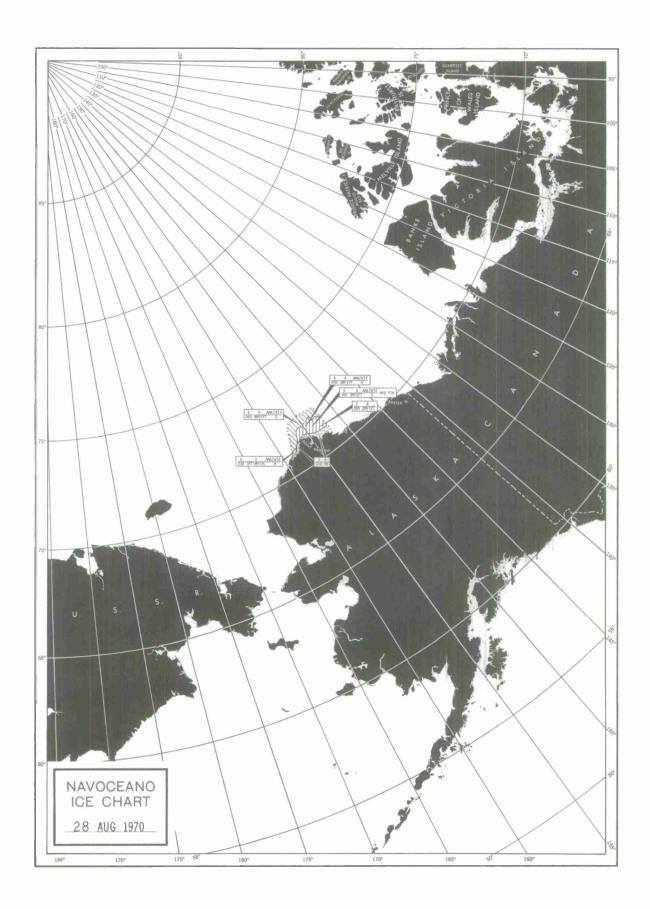


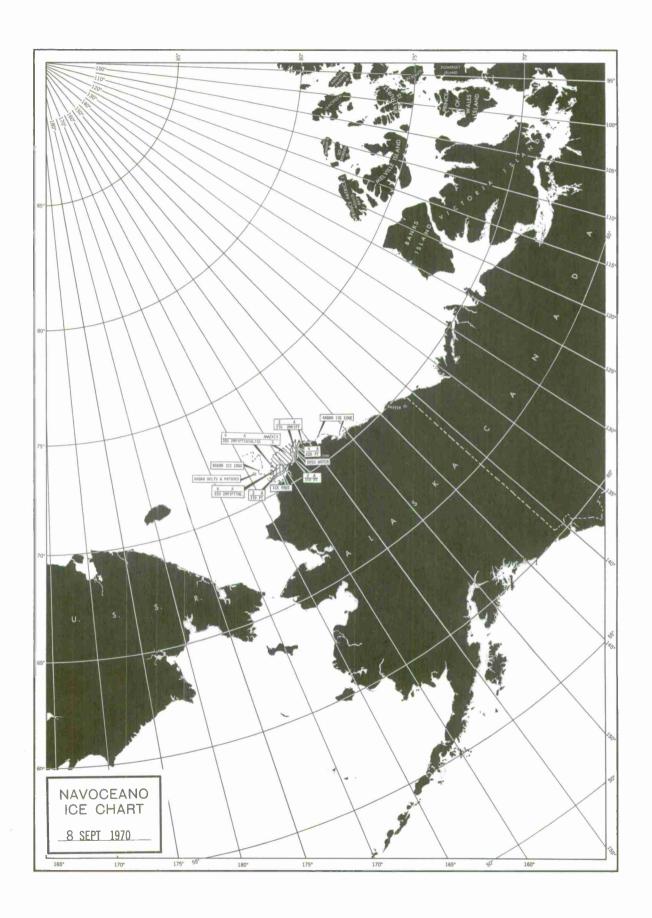


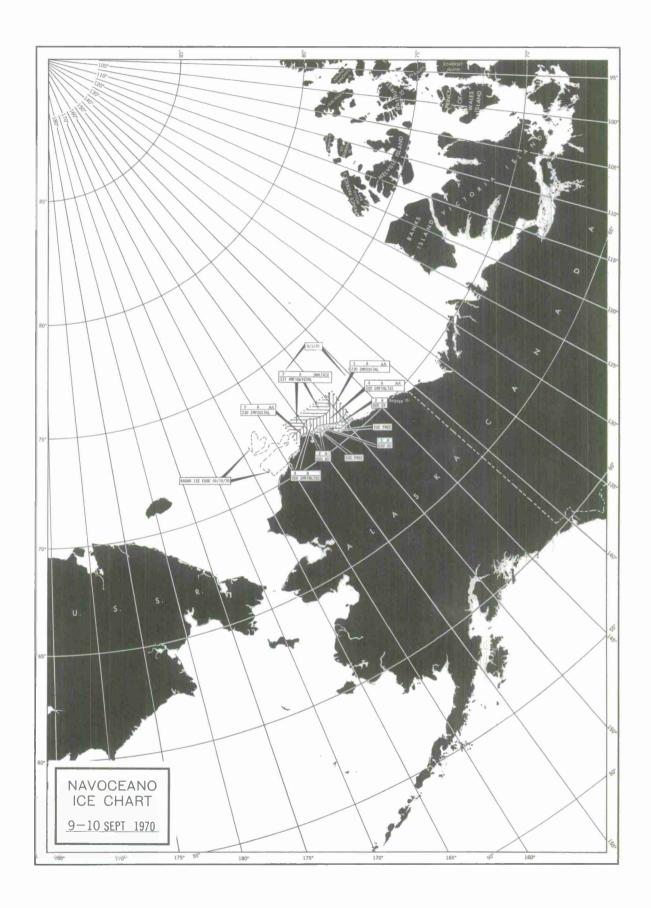


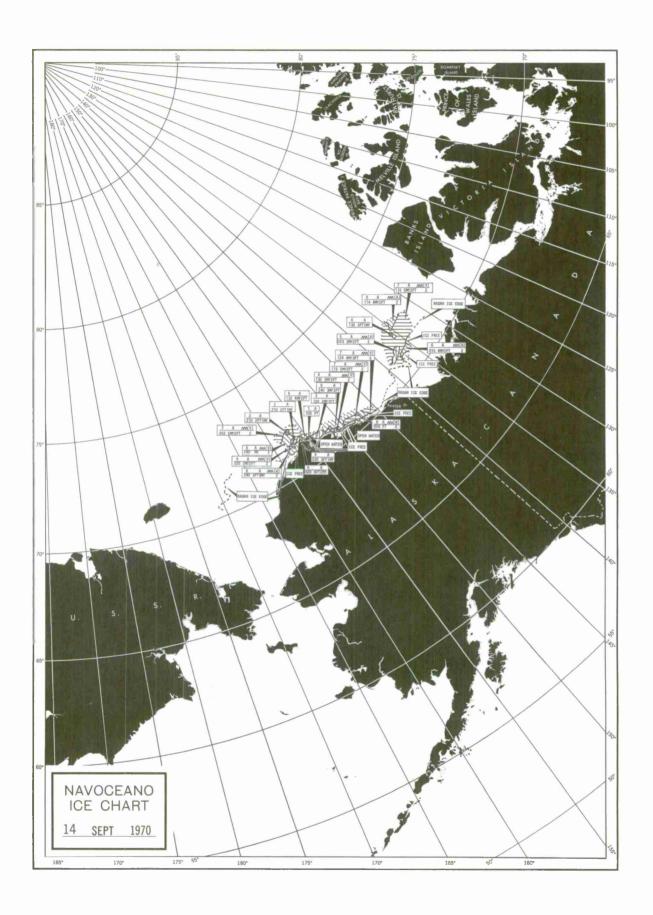


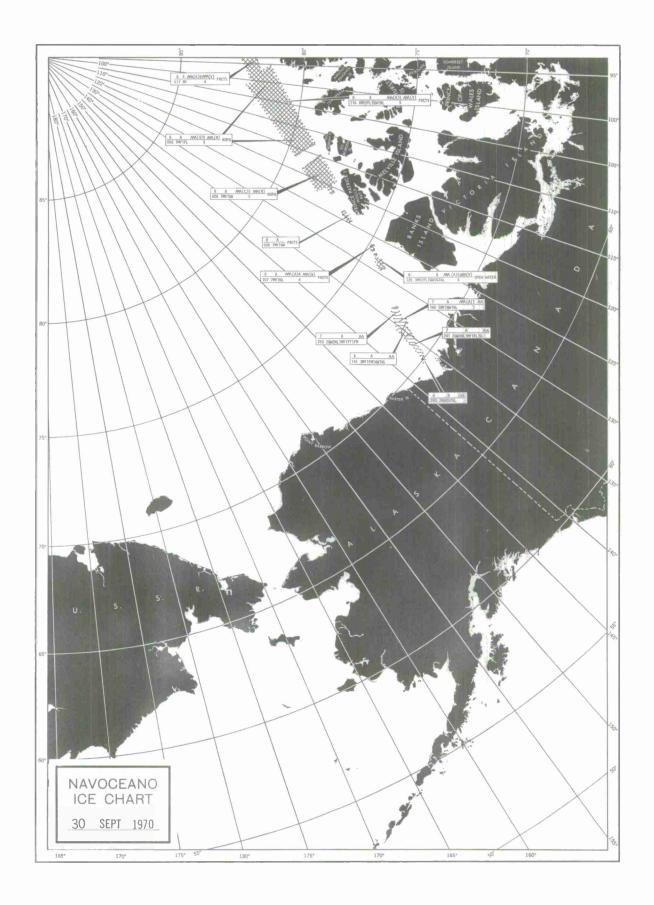


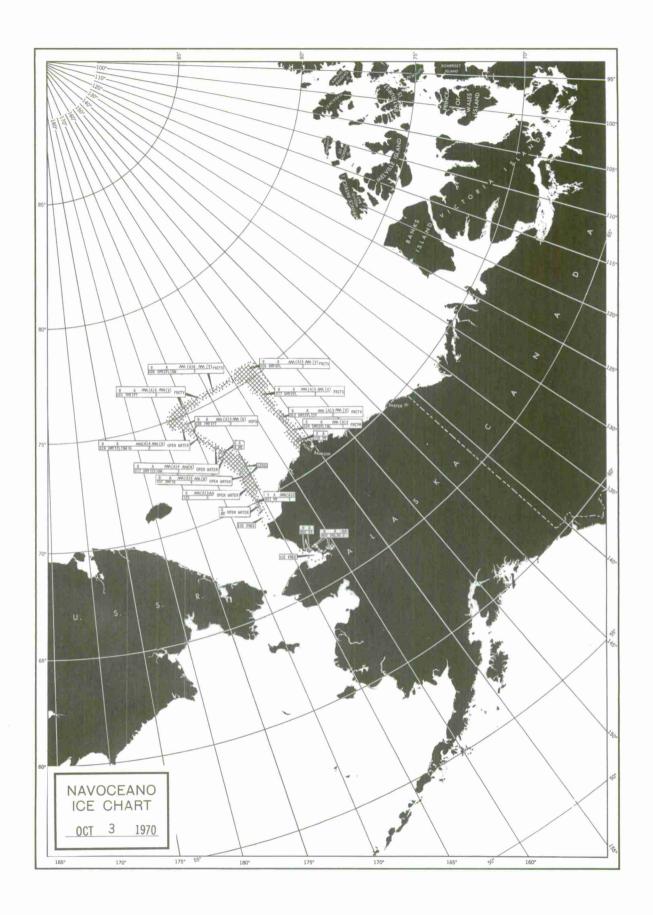


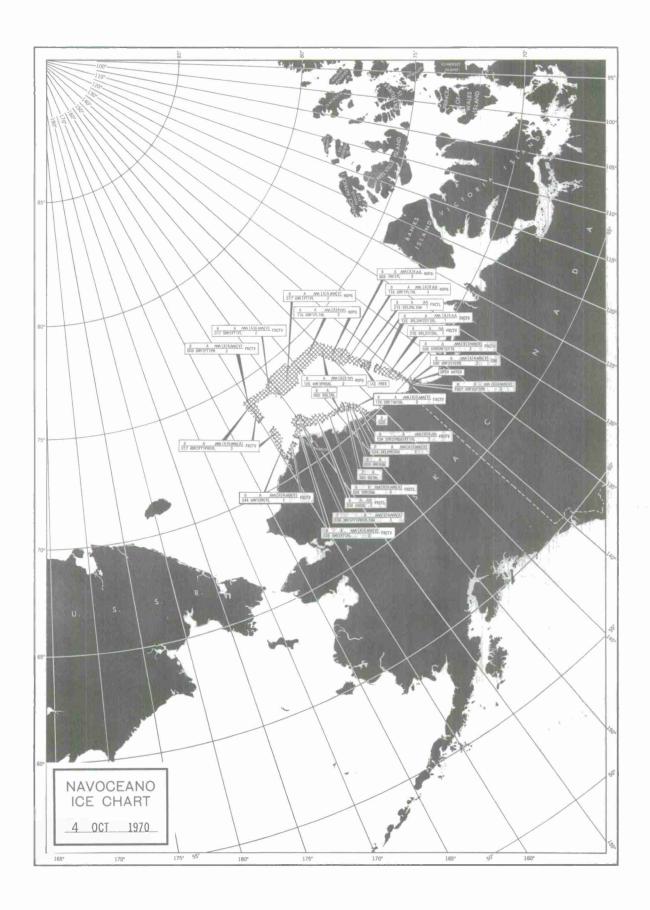




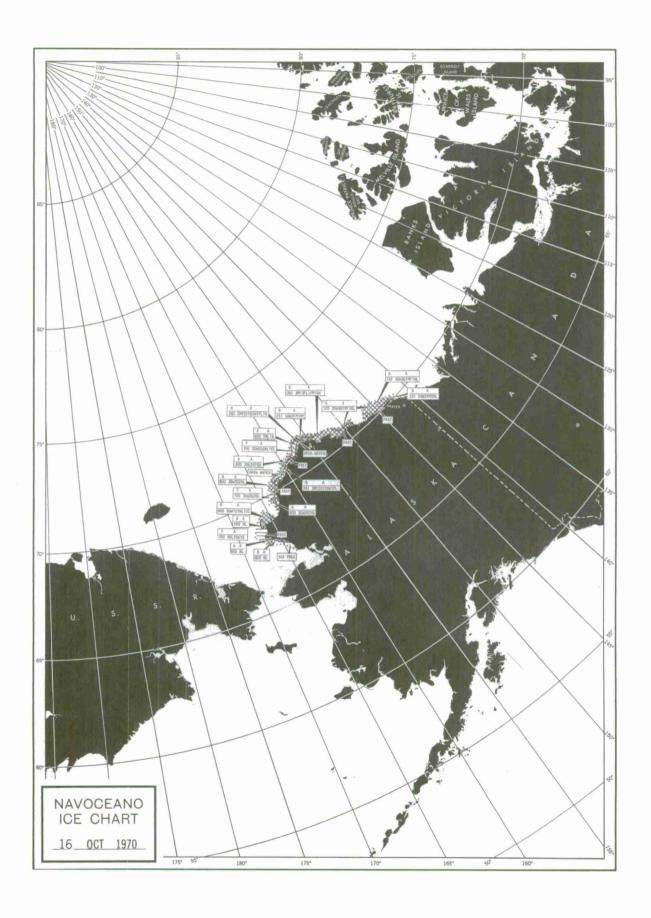


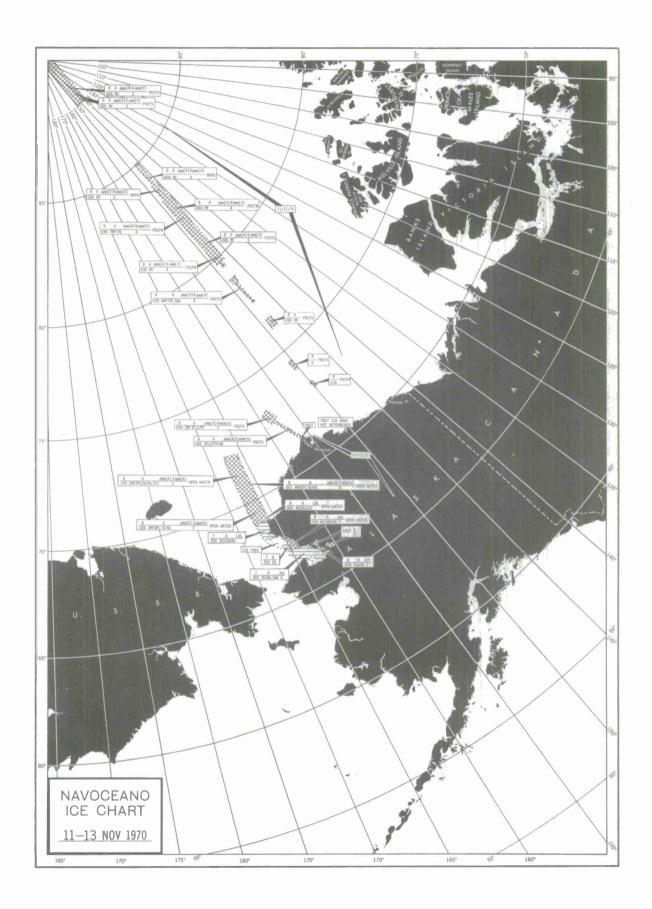


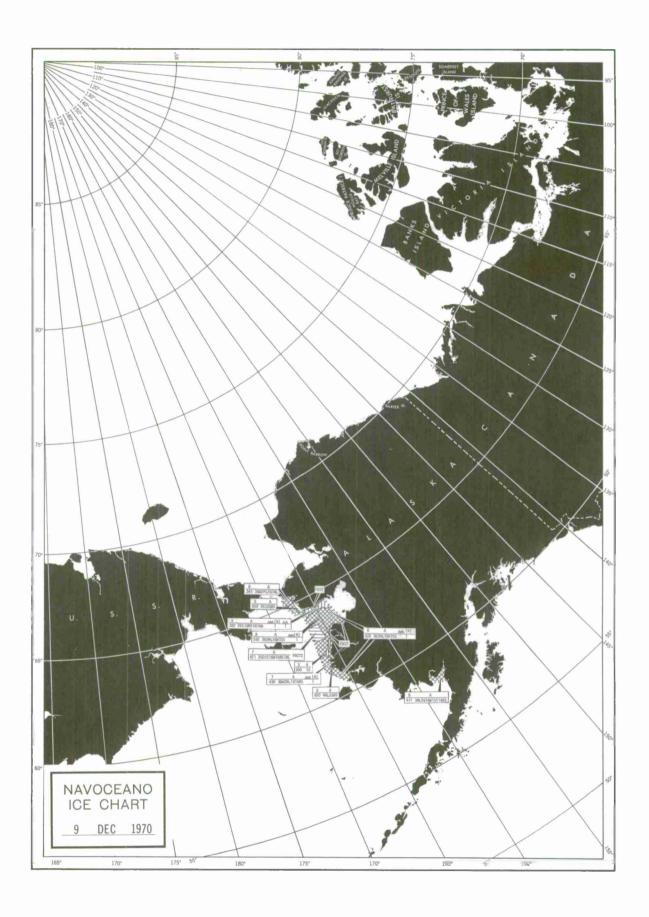




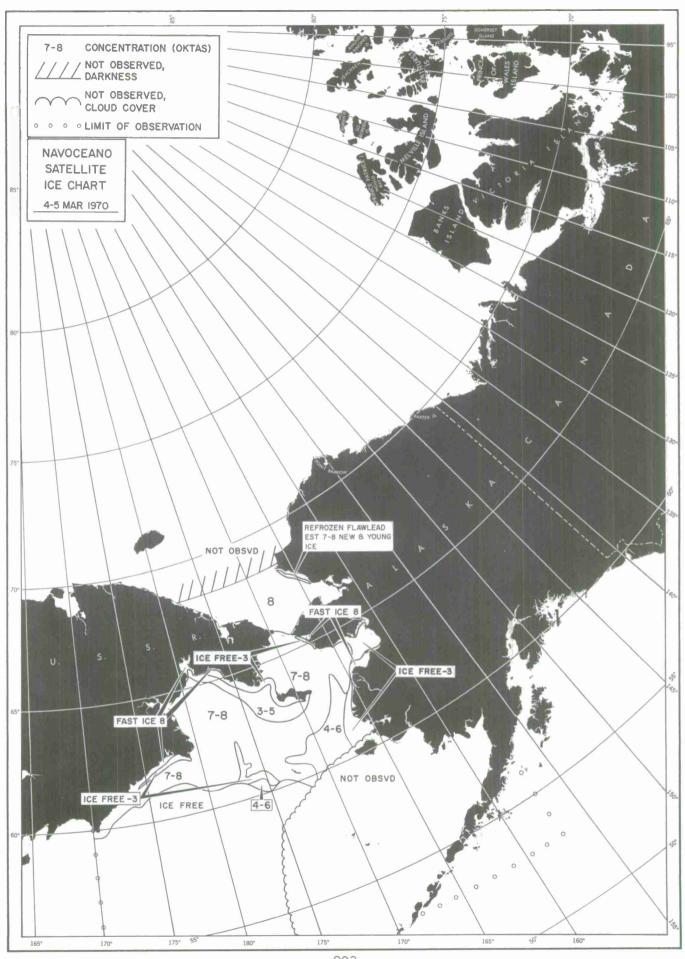
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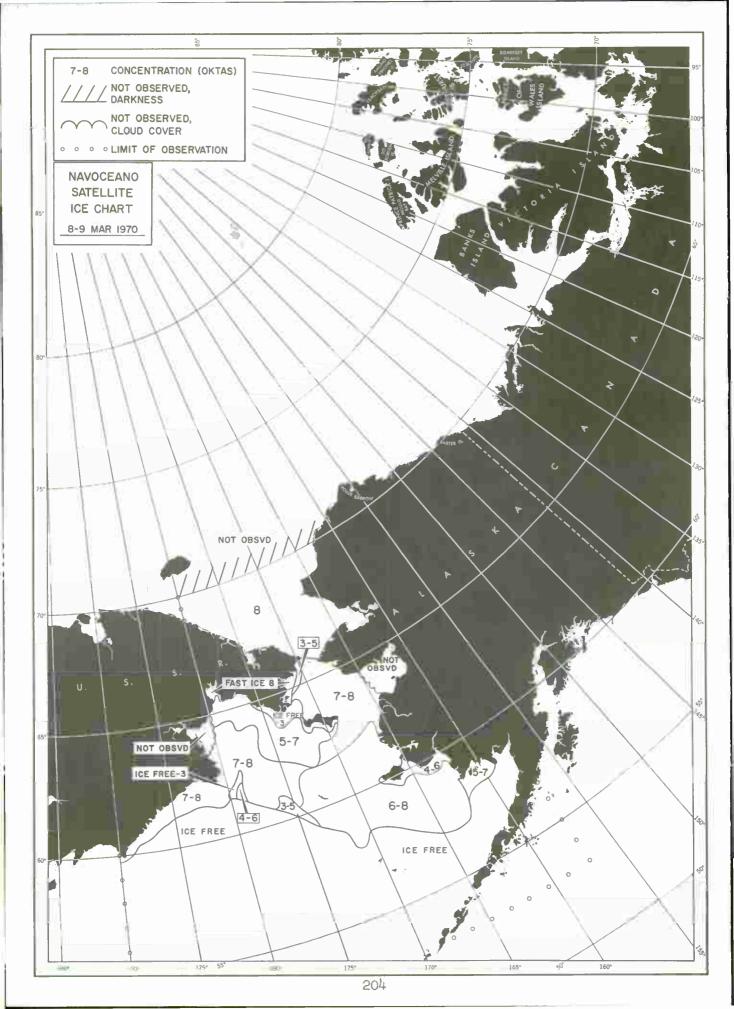


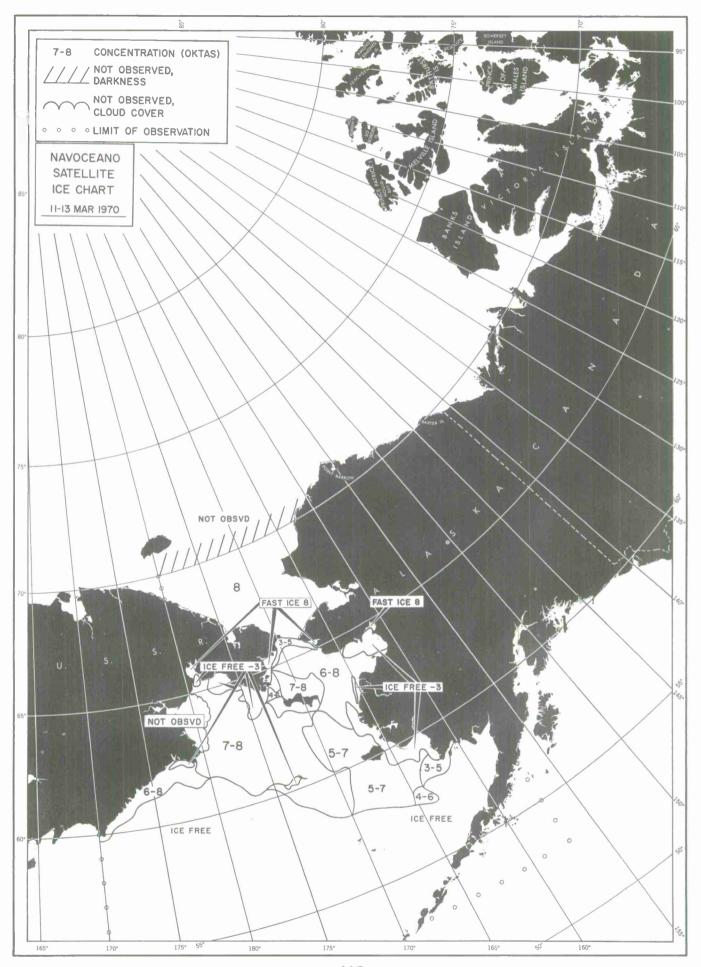


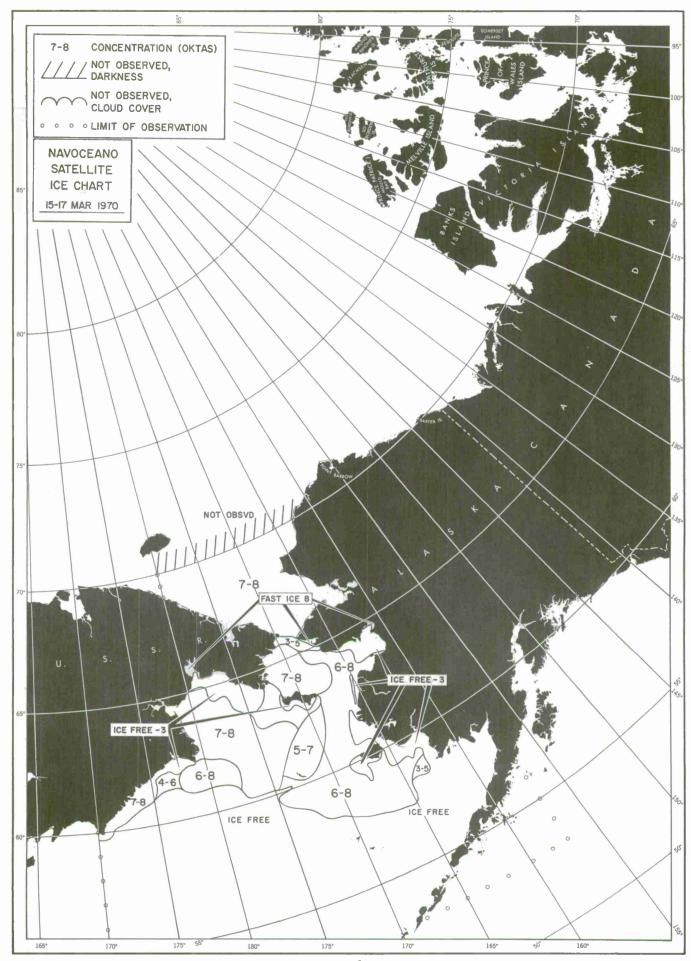


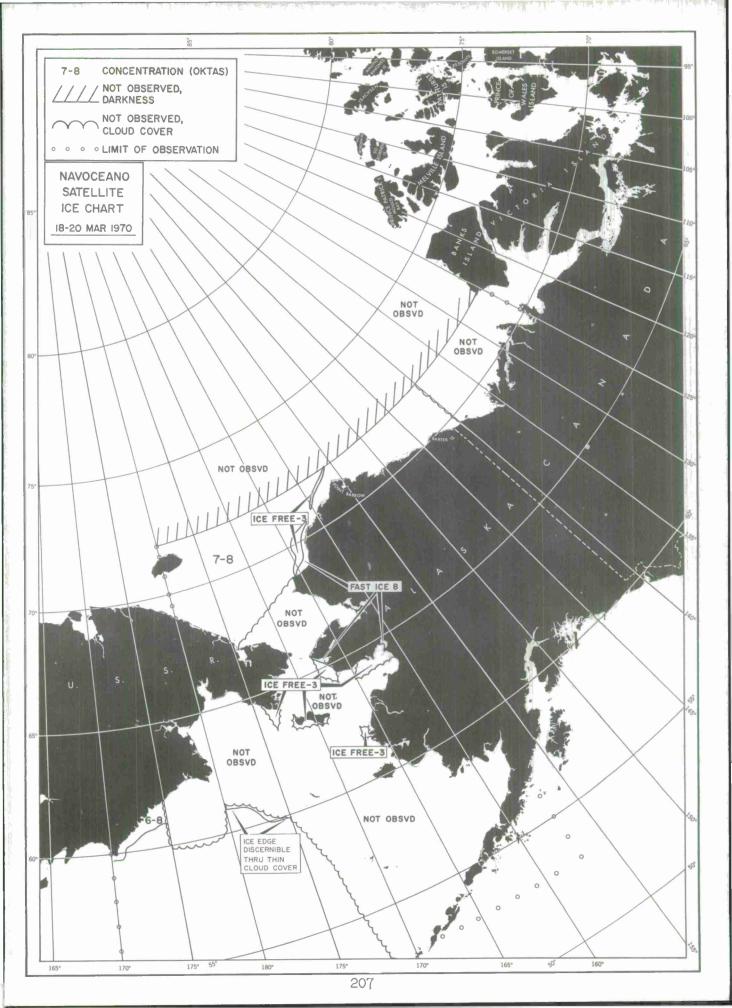
APPENDIX D WESTERN ARCTIC ICE CHARTS OBSERVED BY SATELLITE

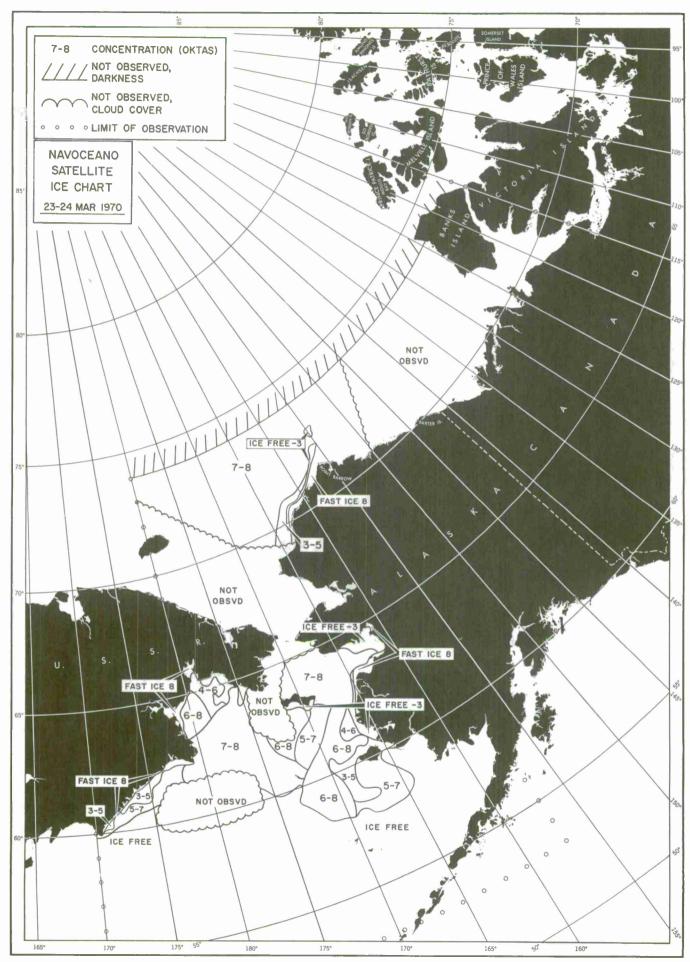


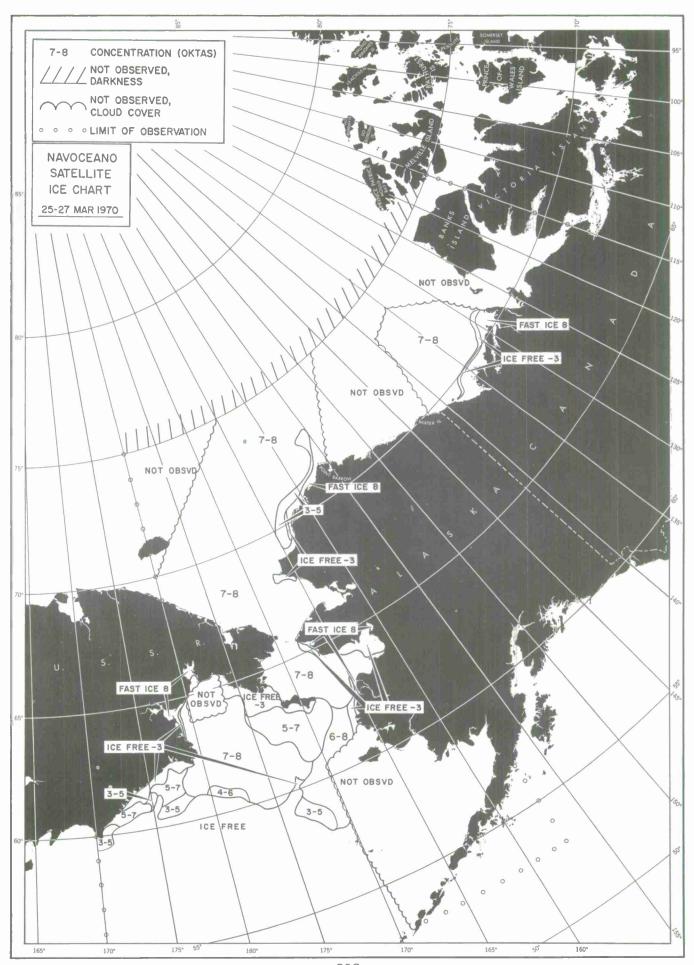


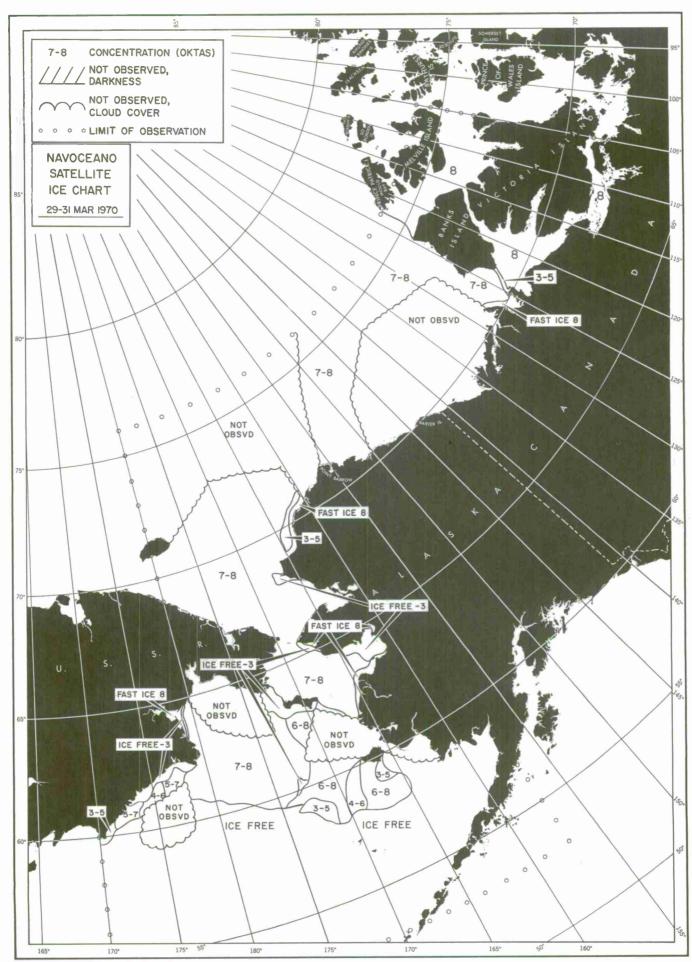


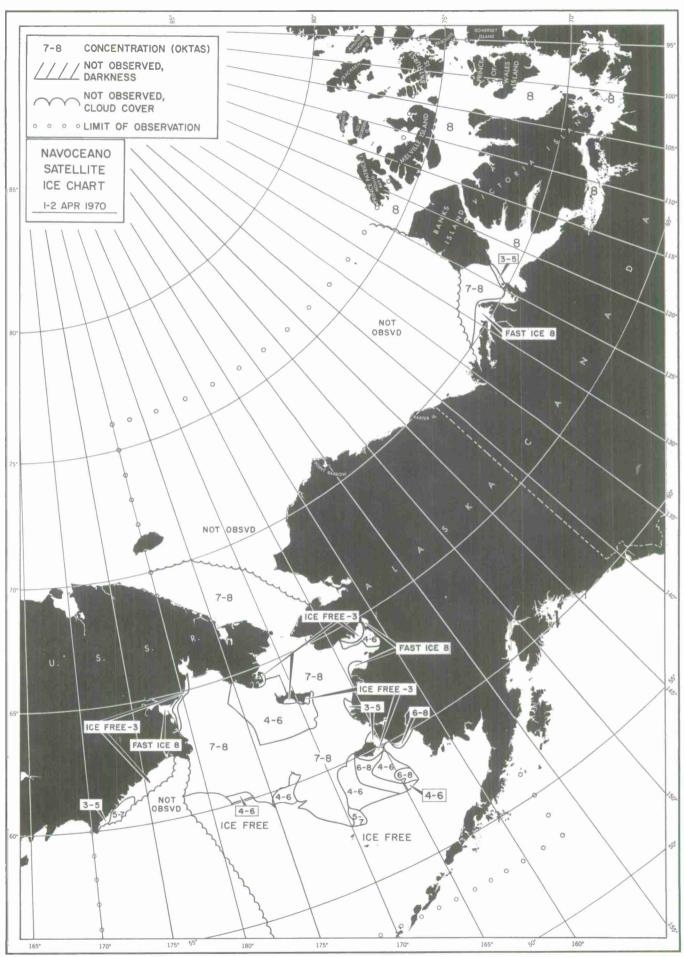


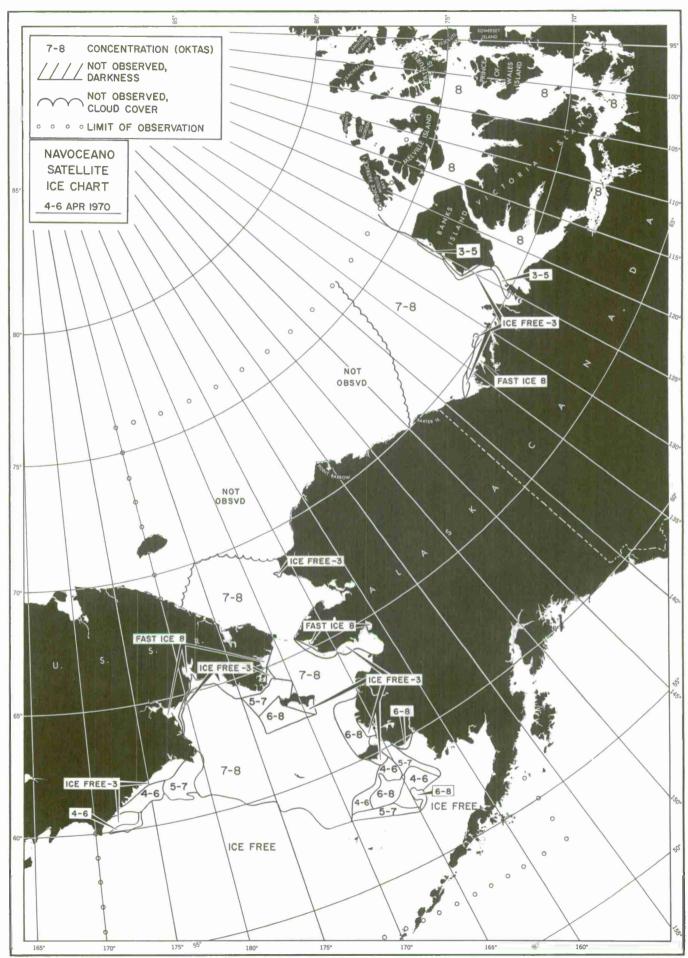


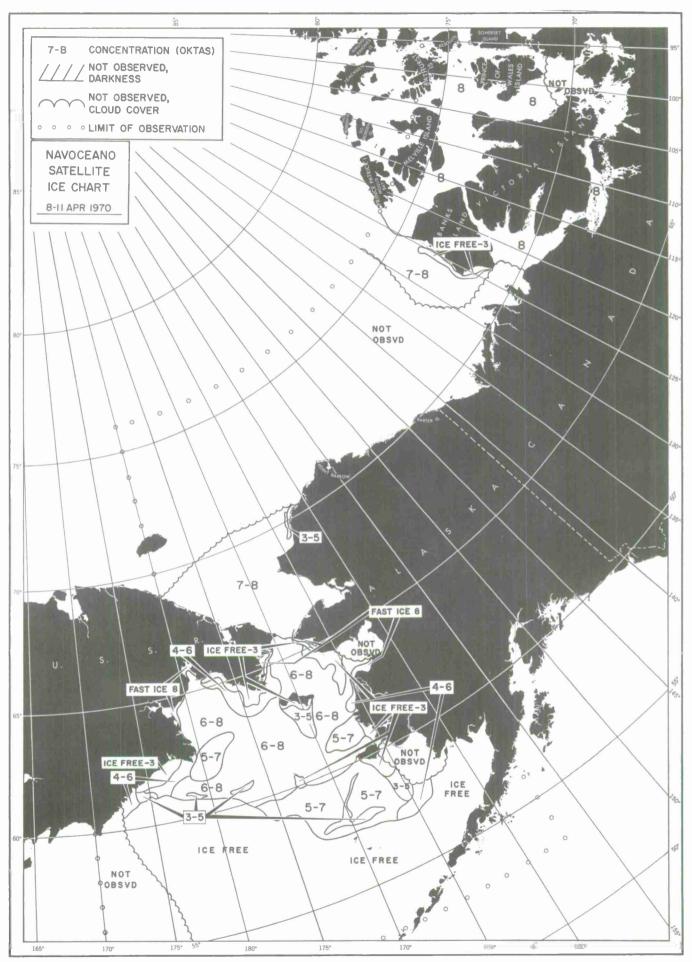


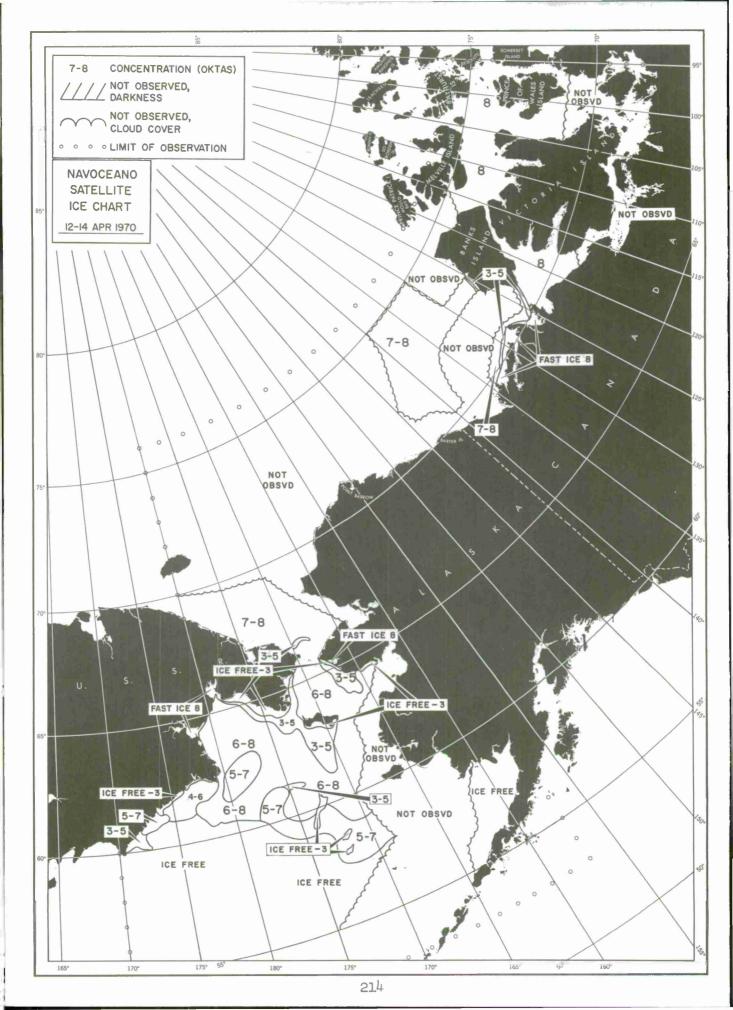


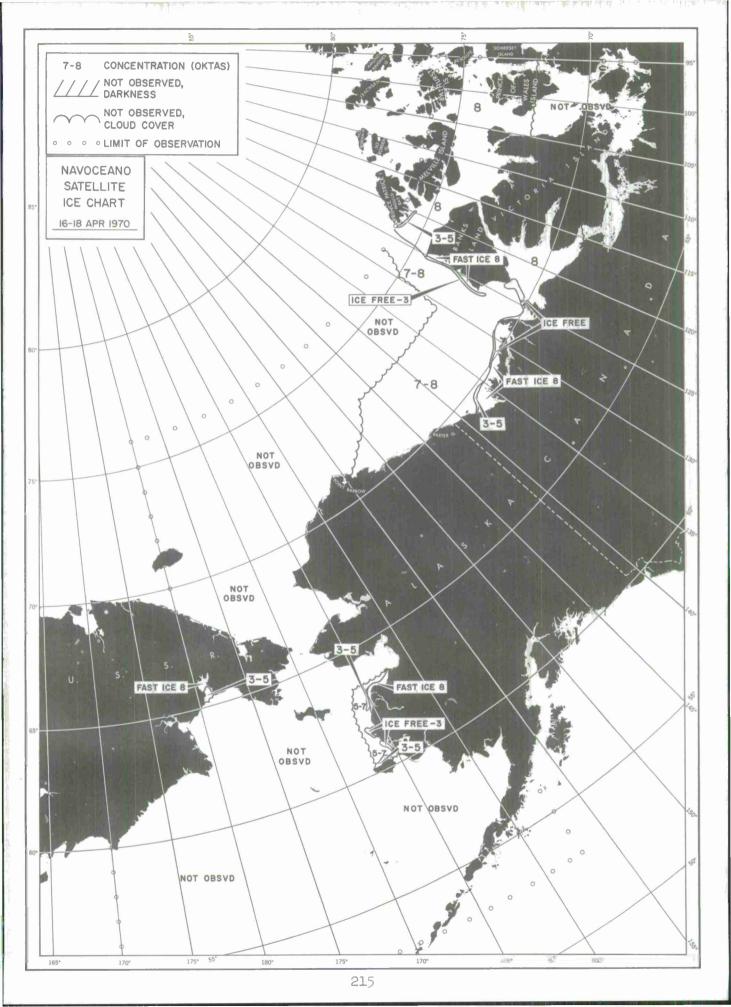


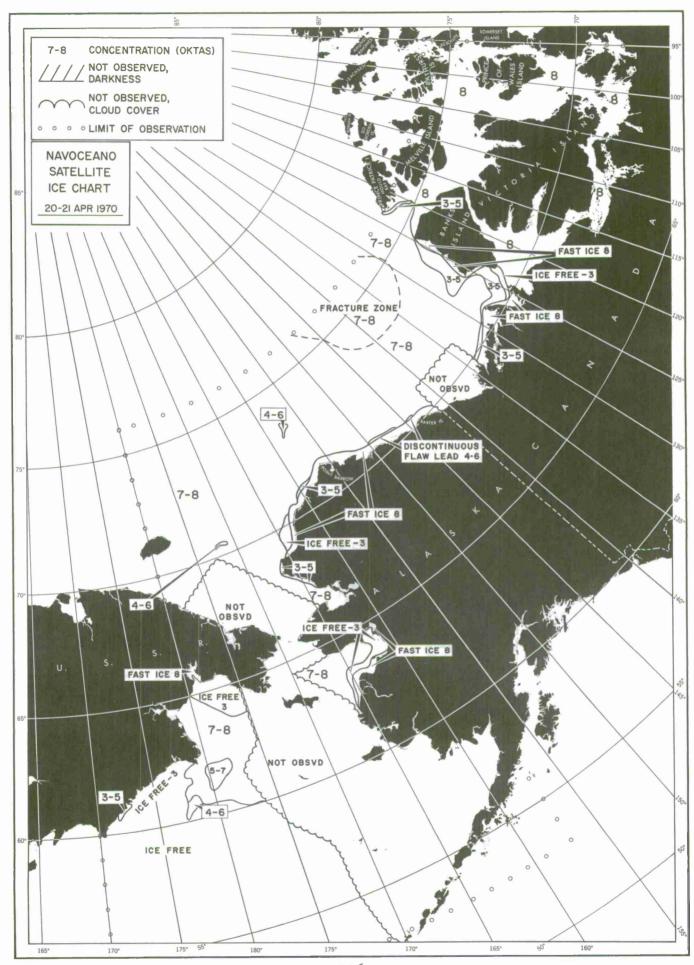


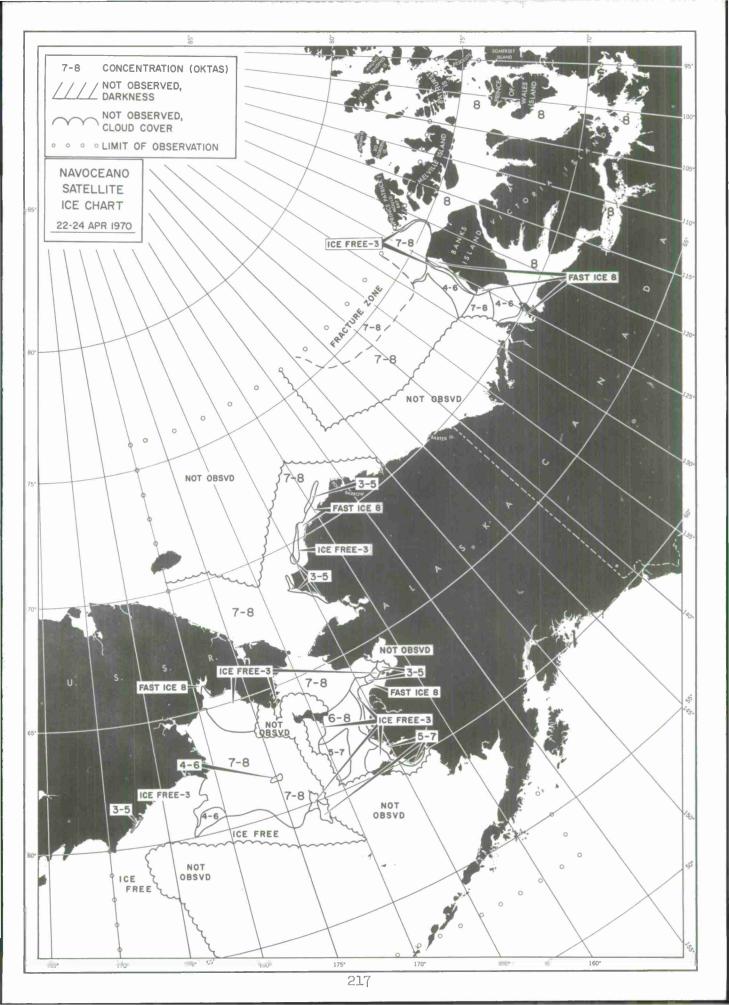


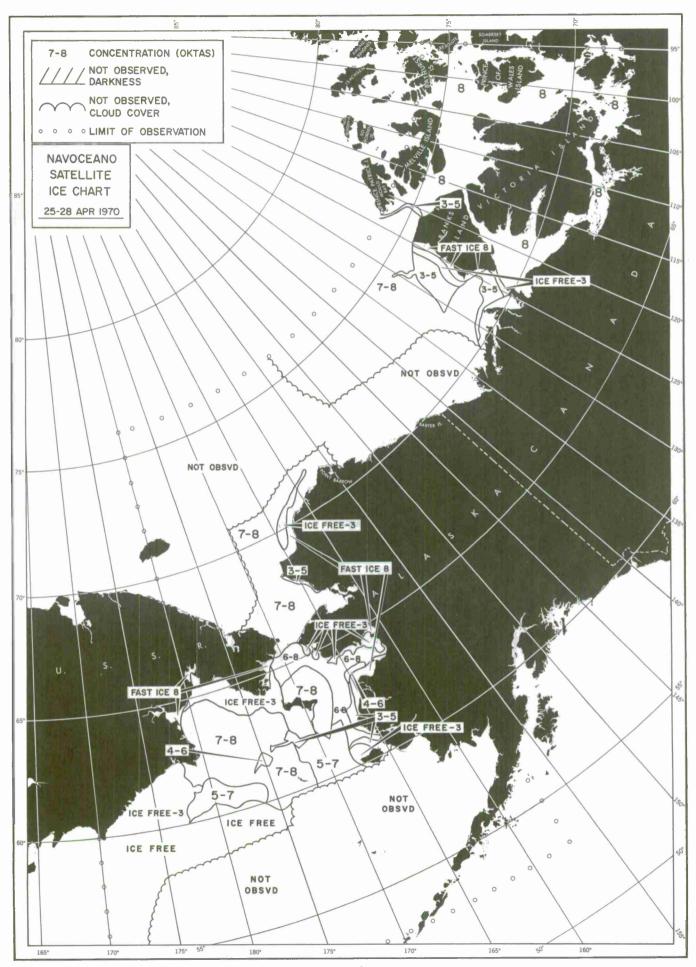


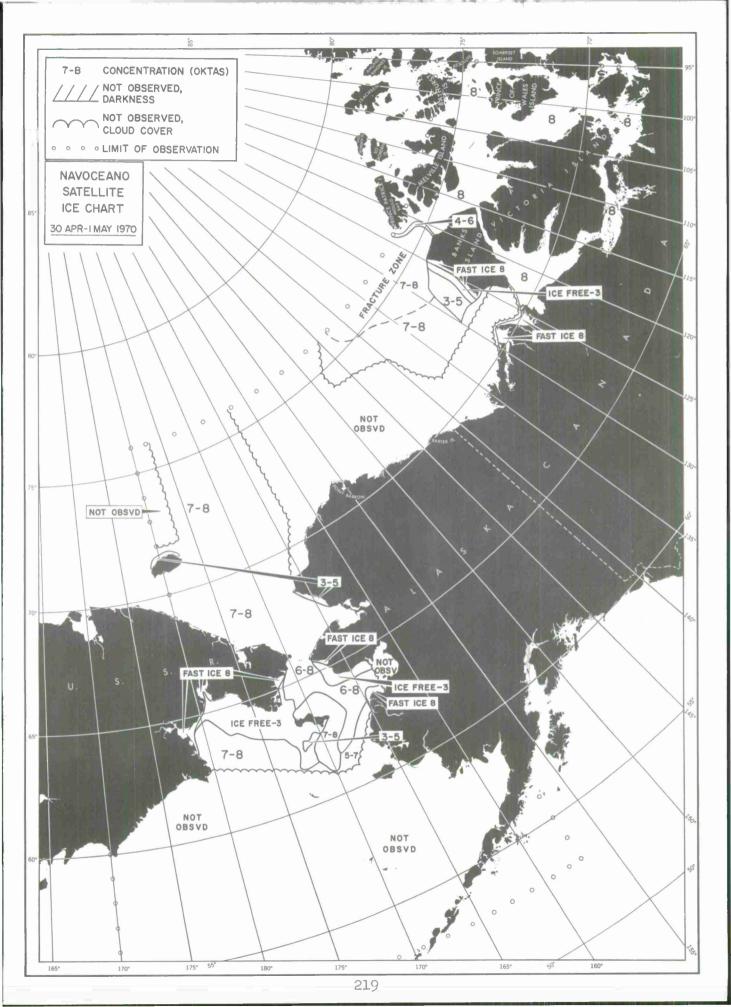


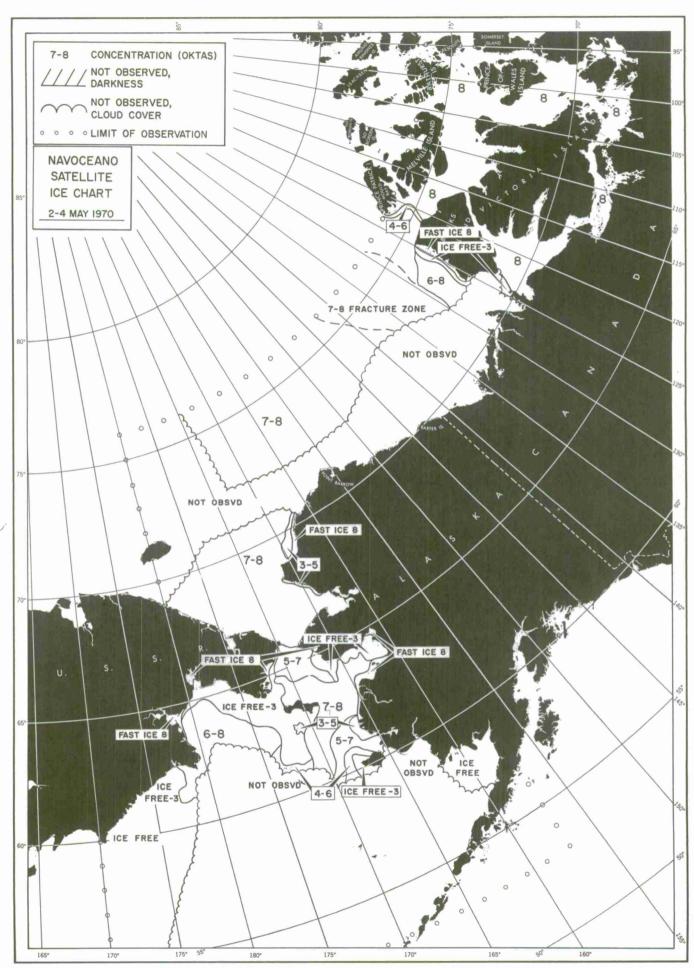


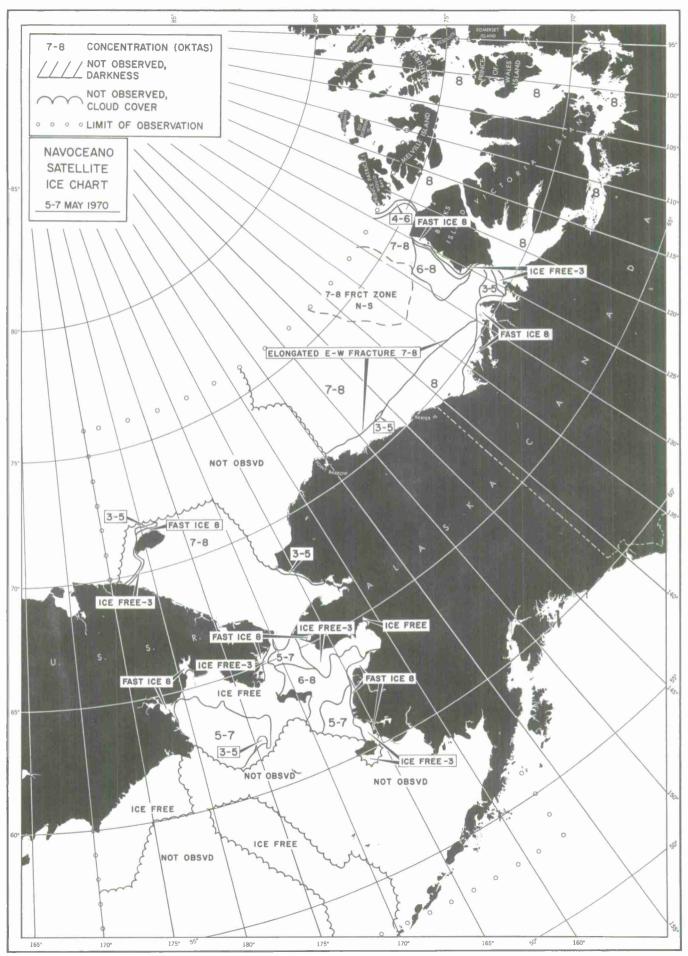


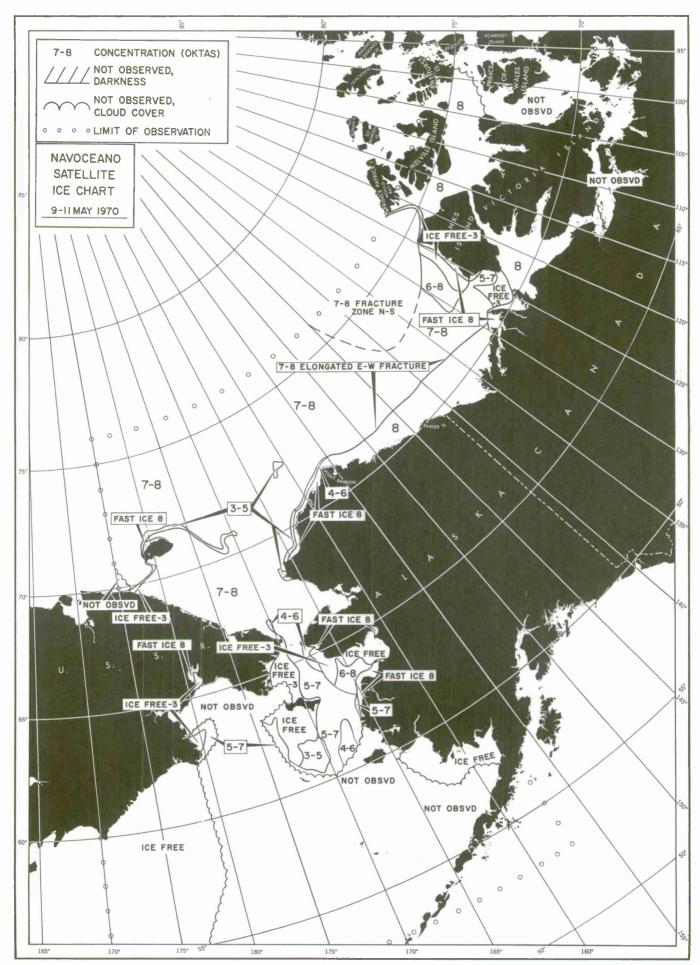


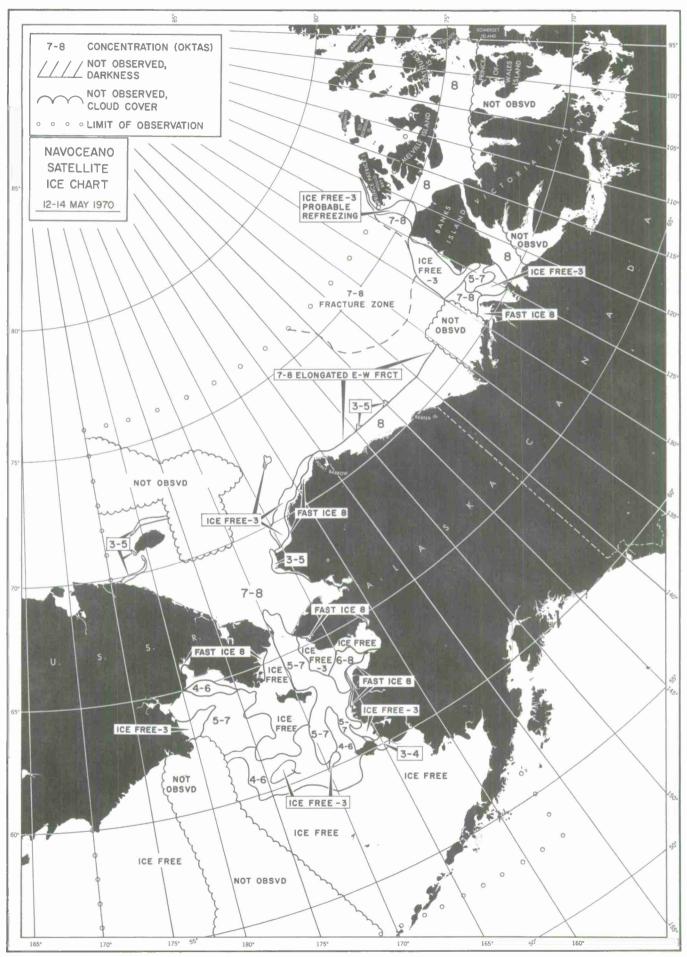


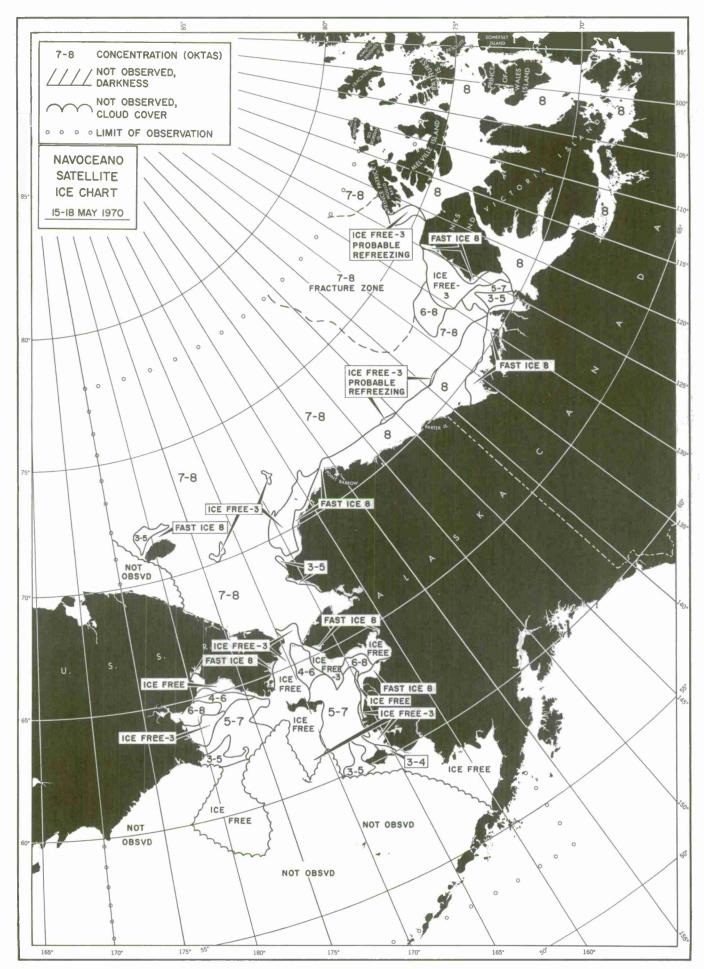


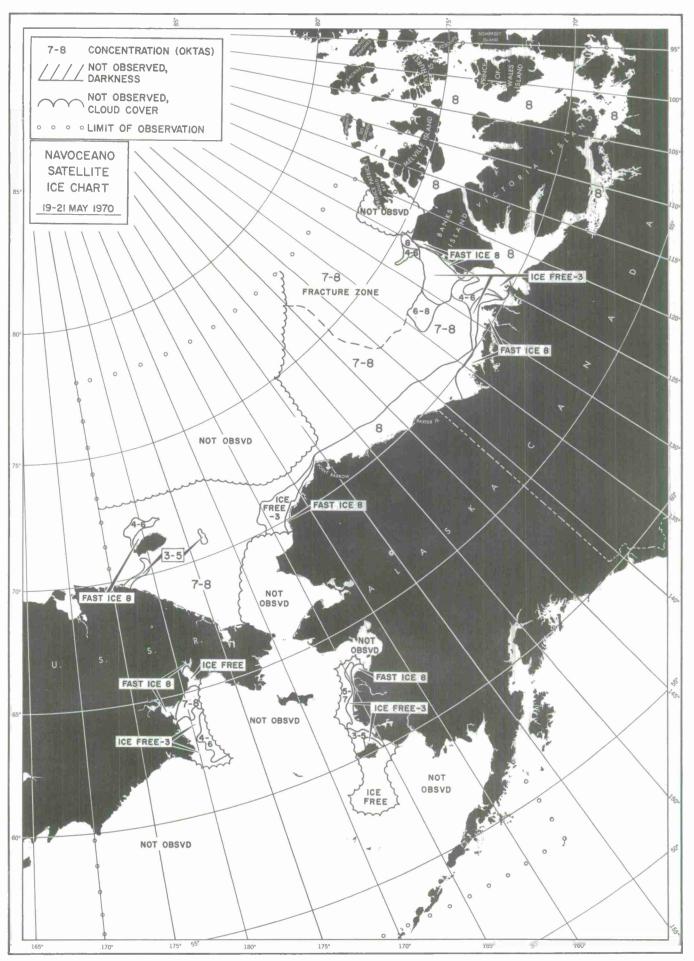


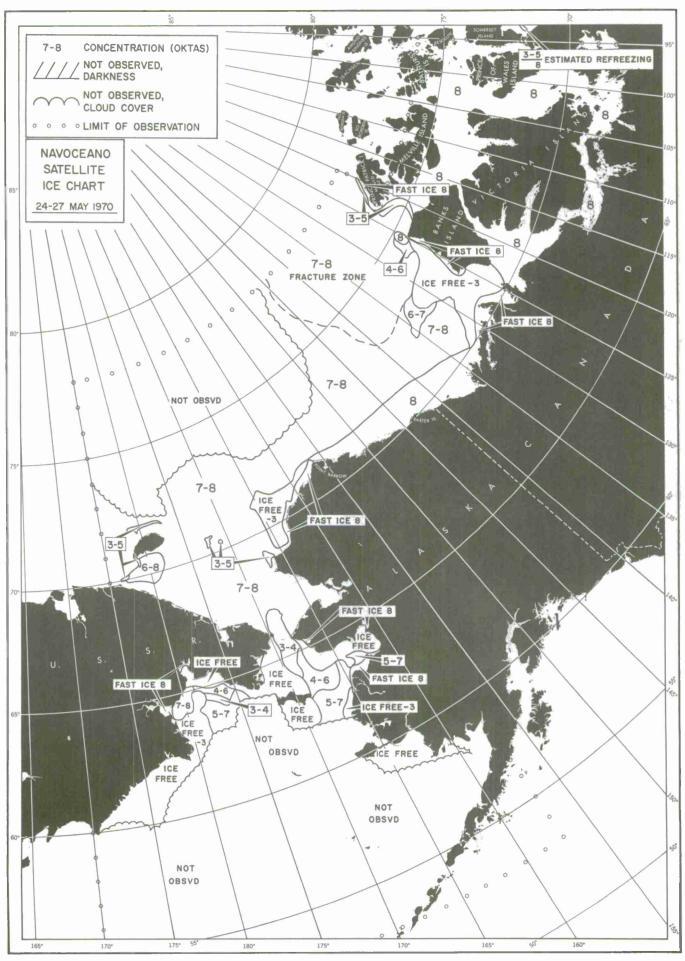


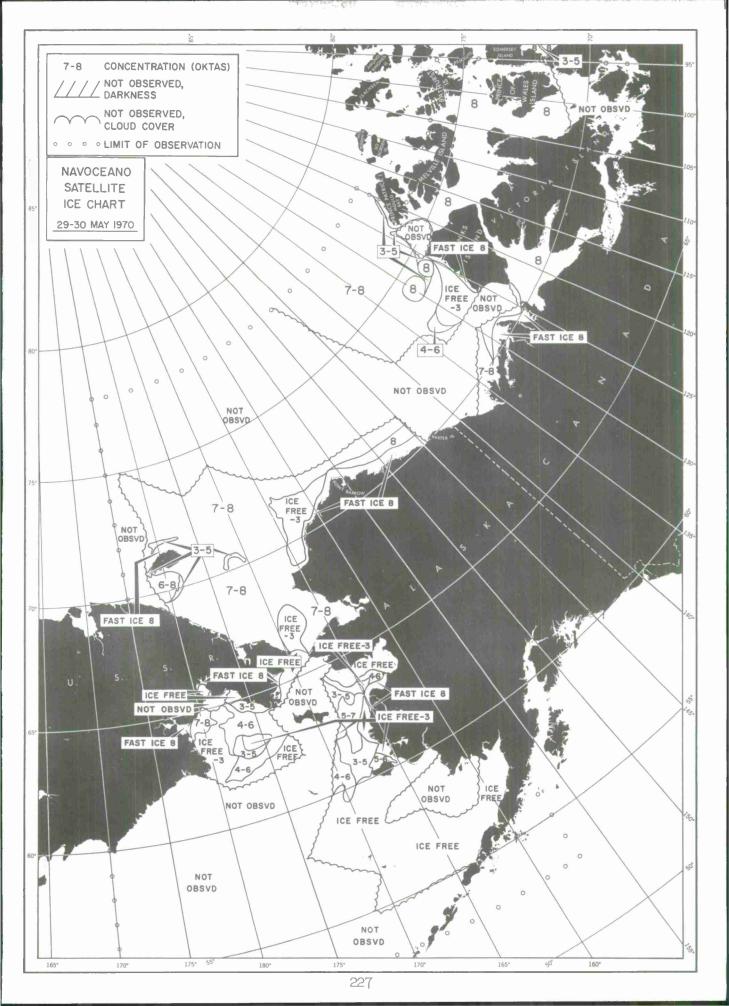


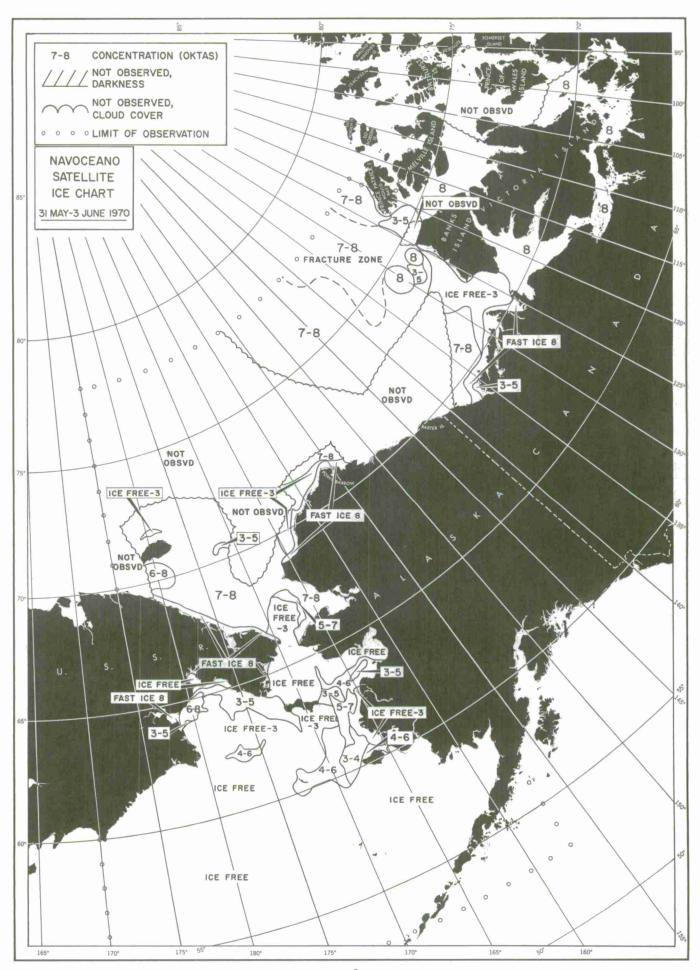


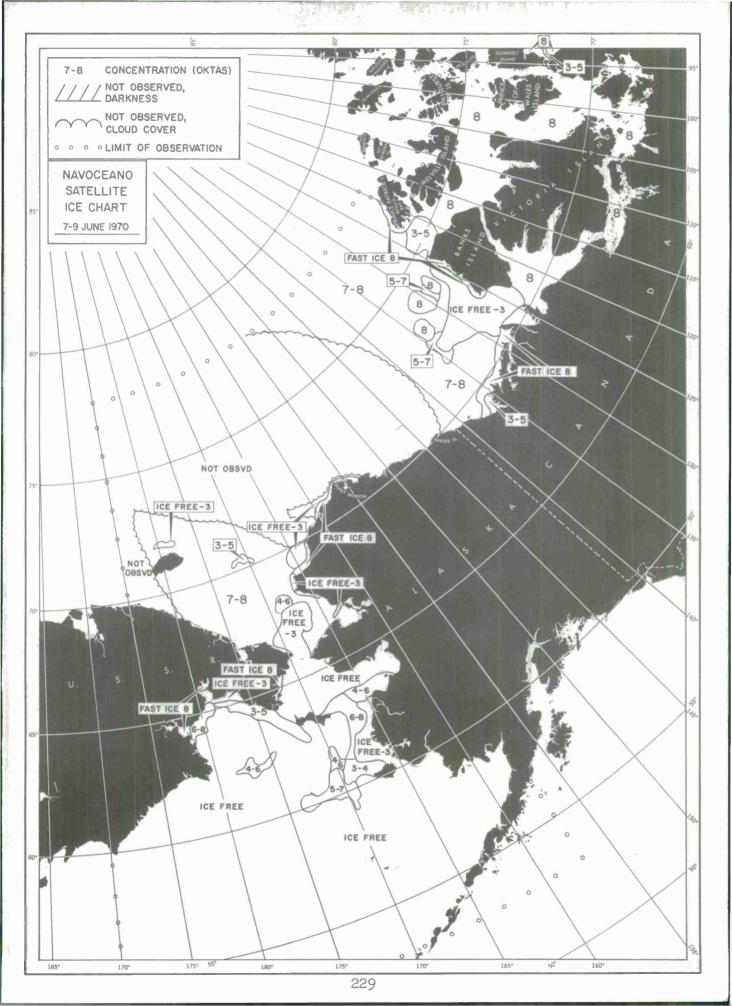


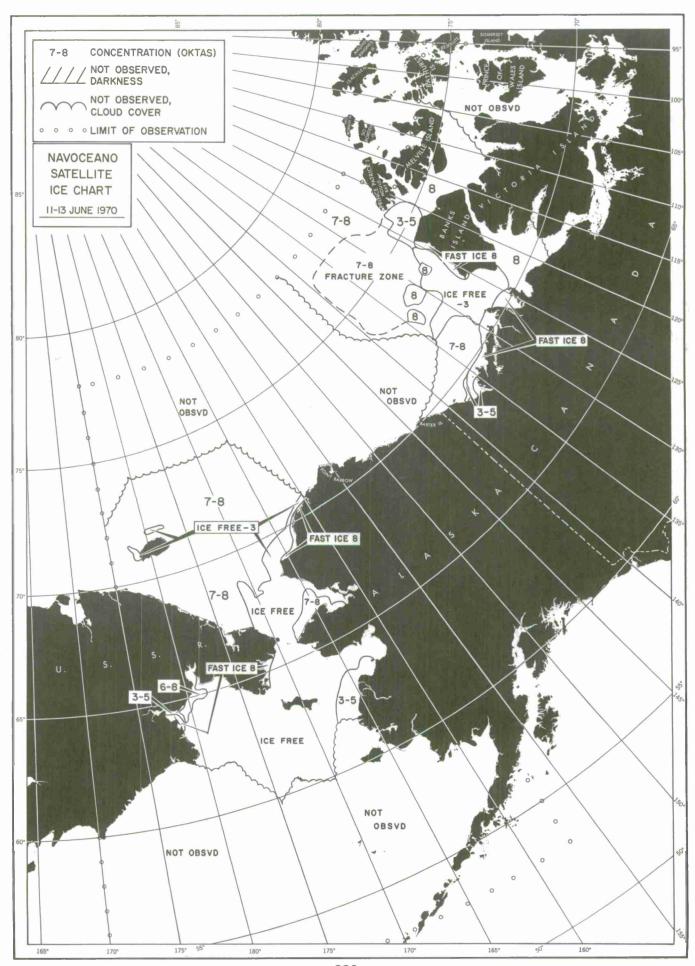


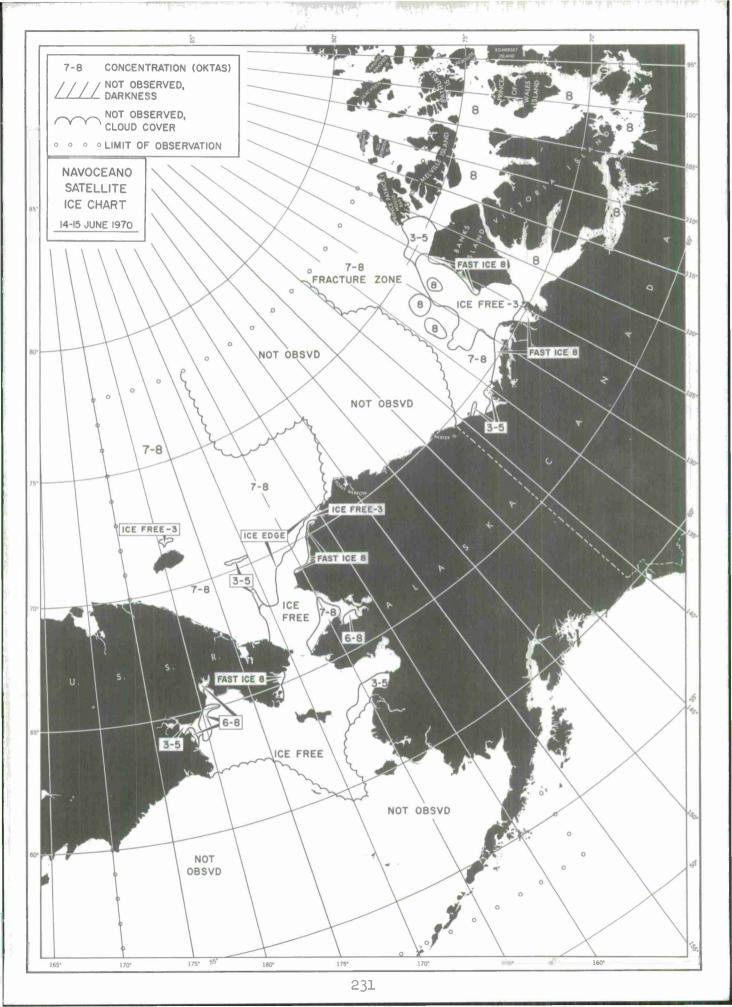


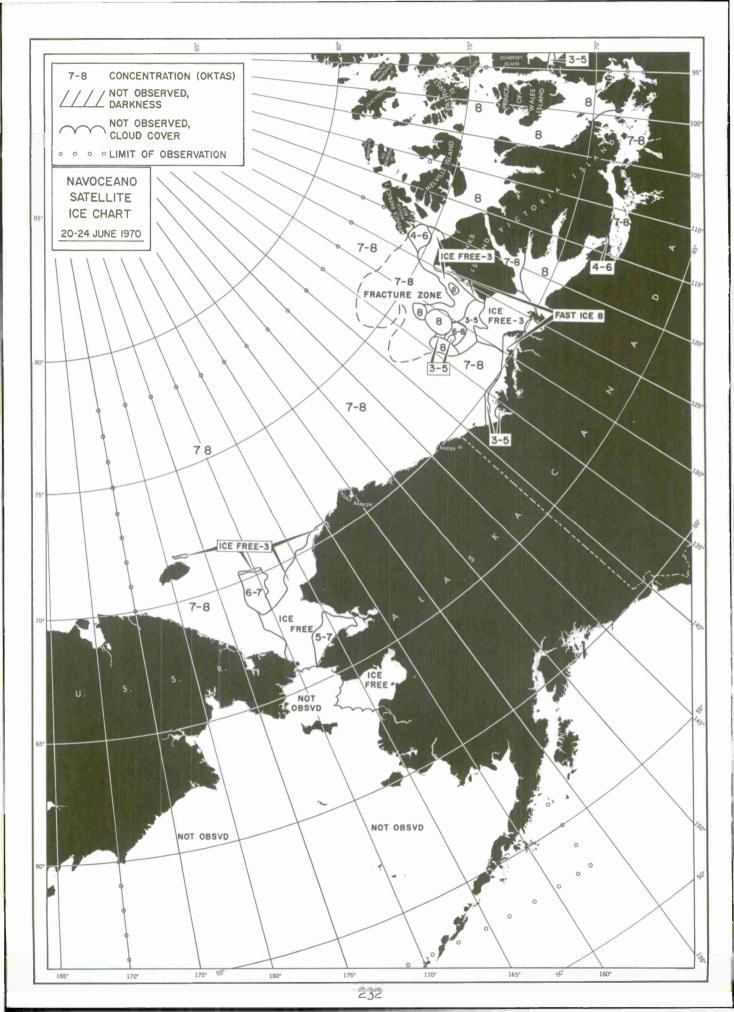


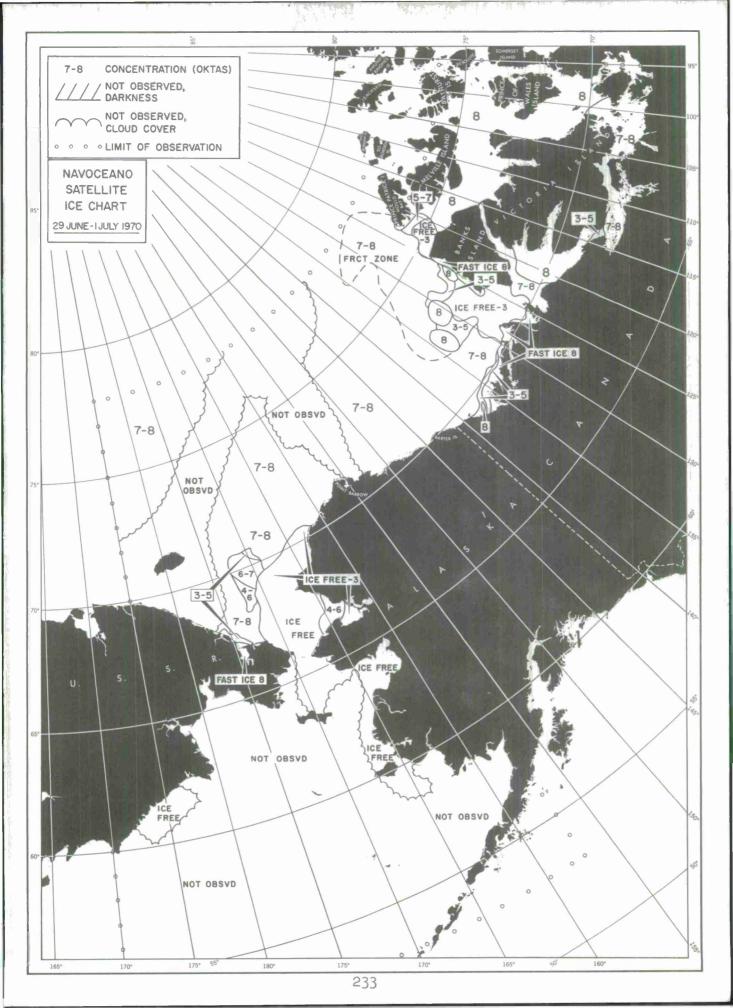


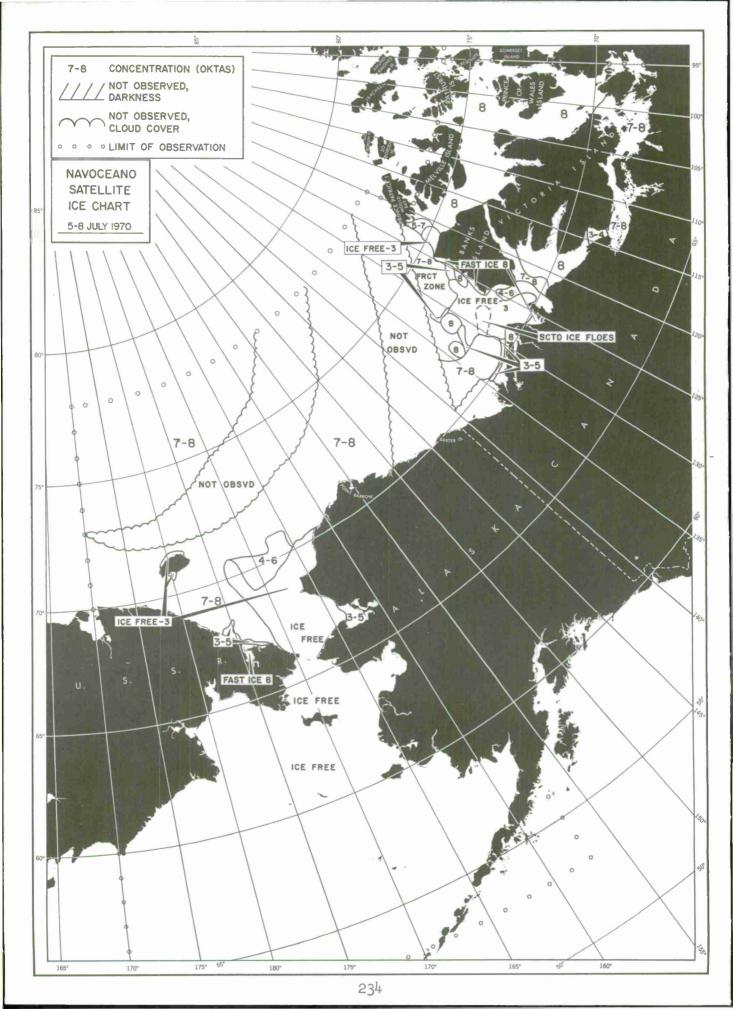


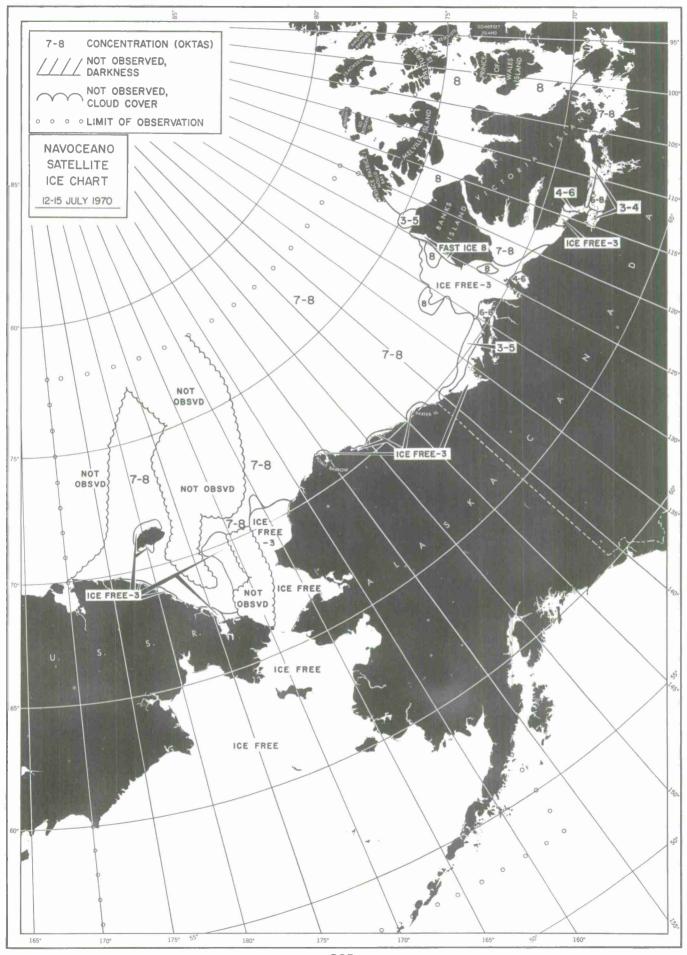


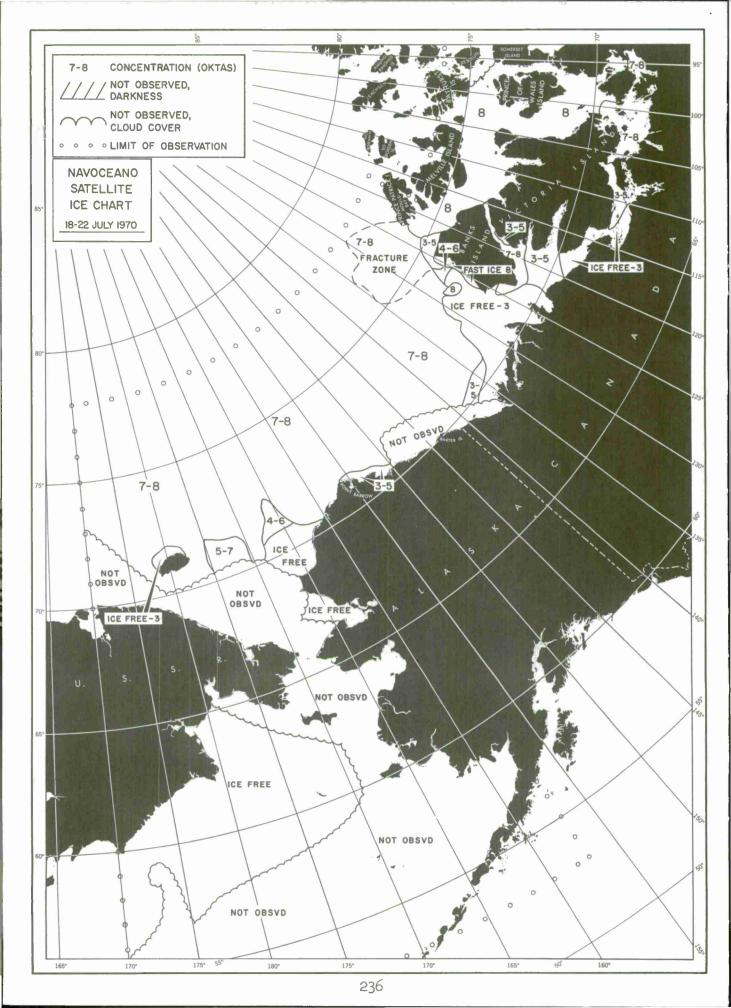


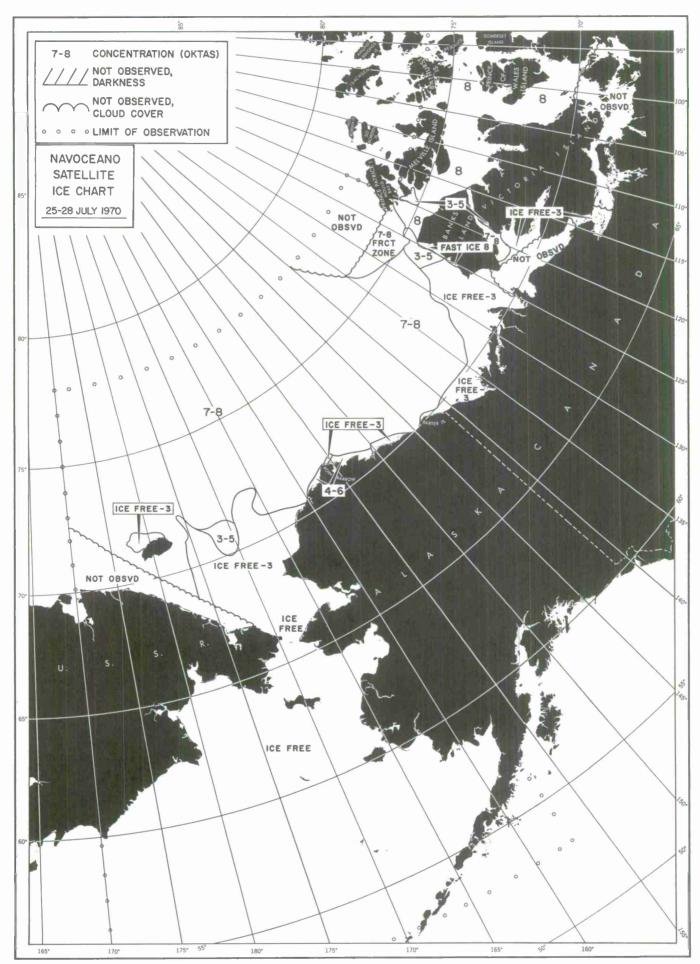


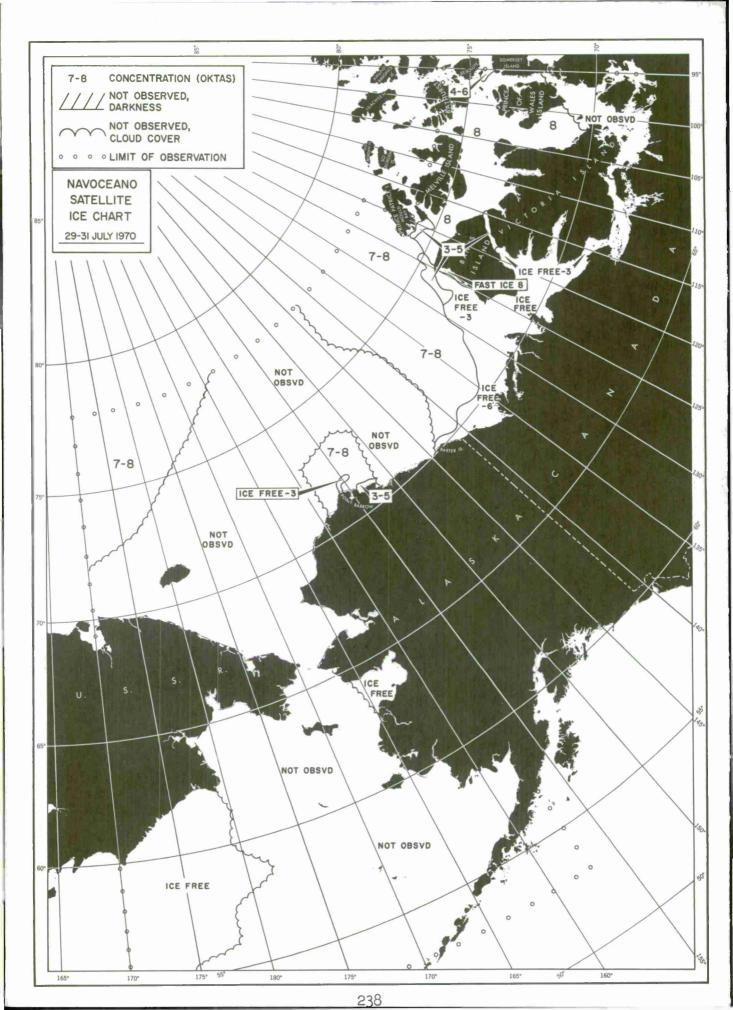


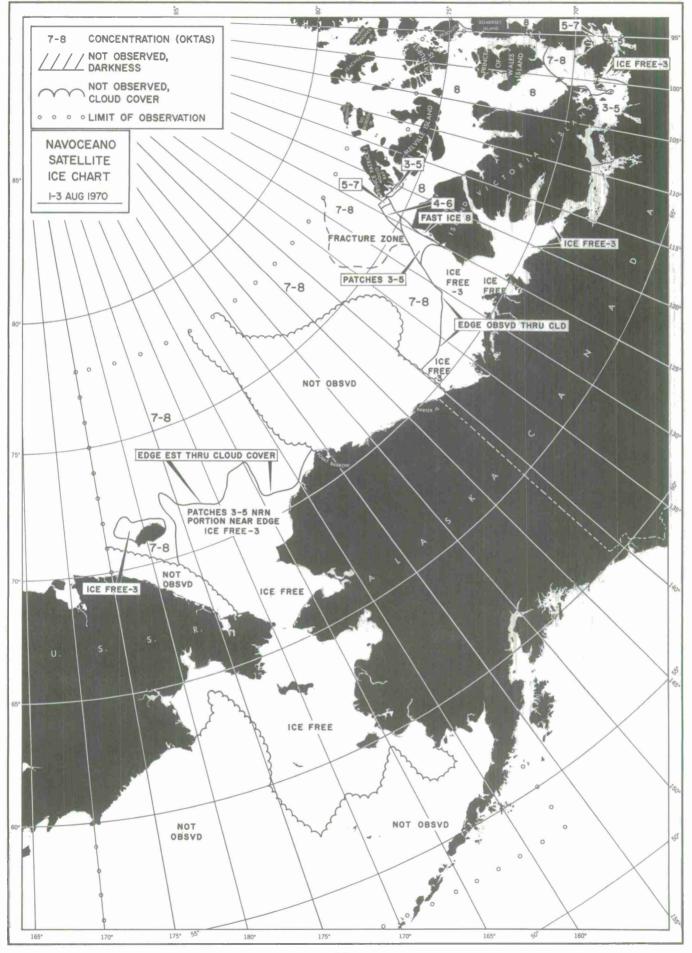


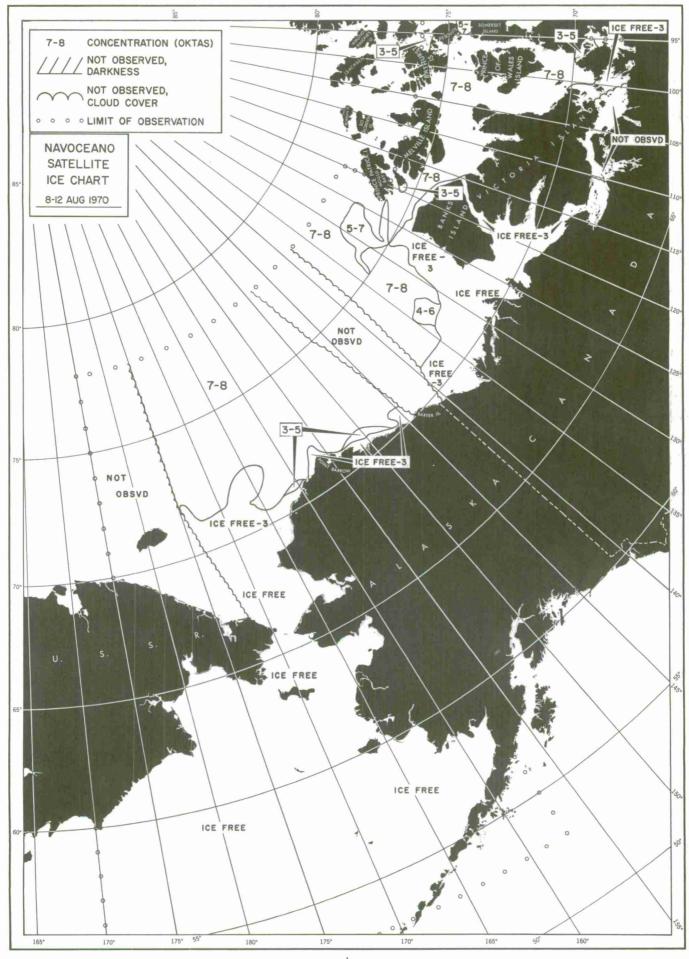


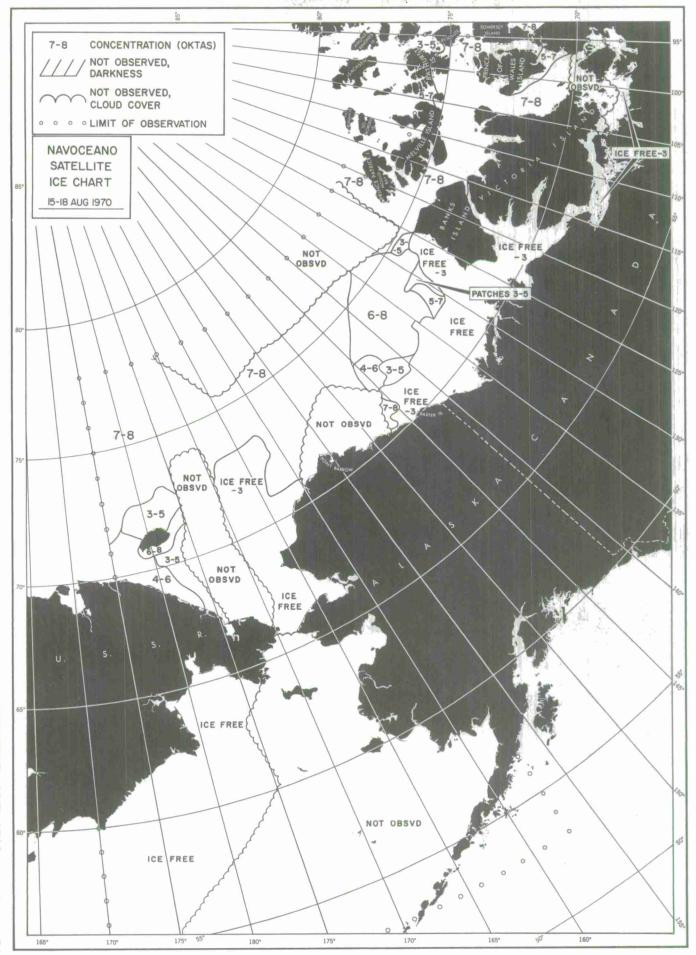


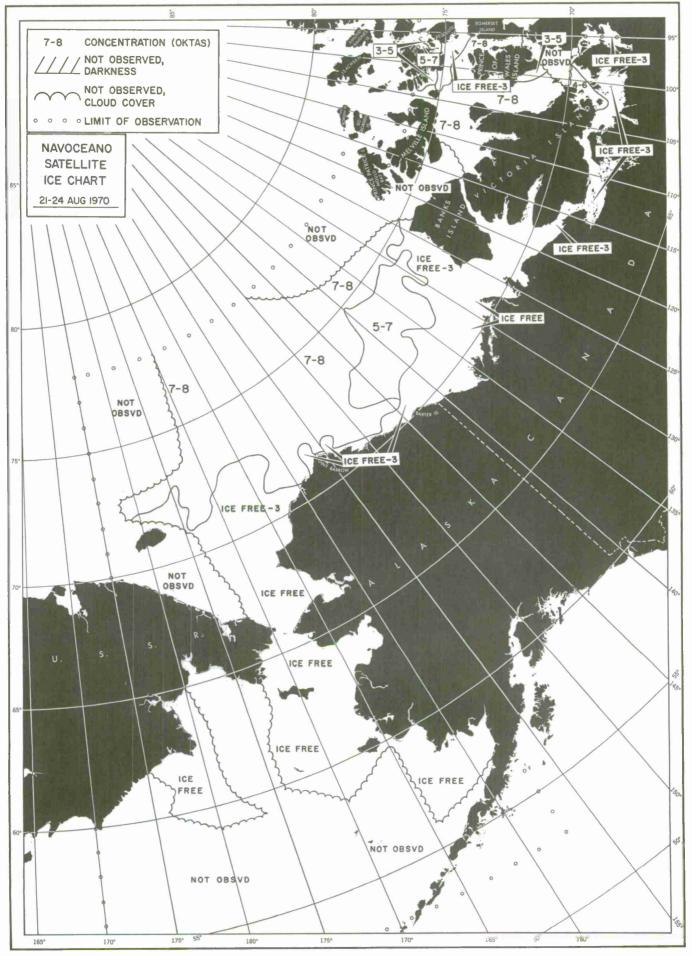


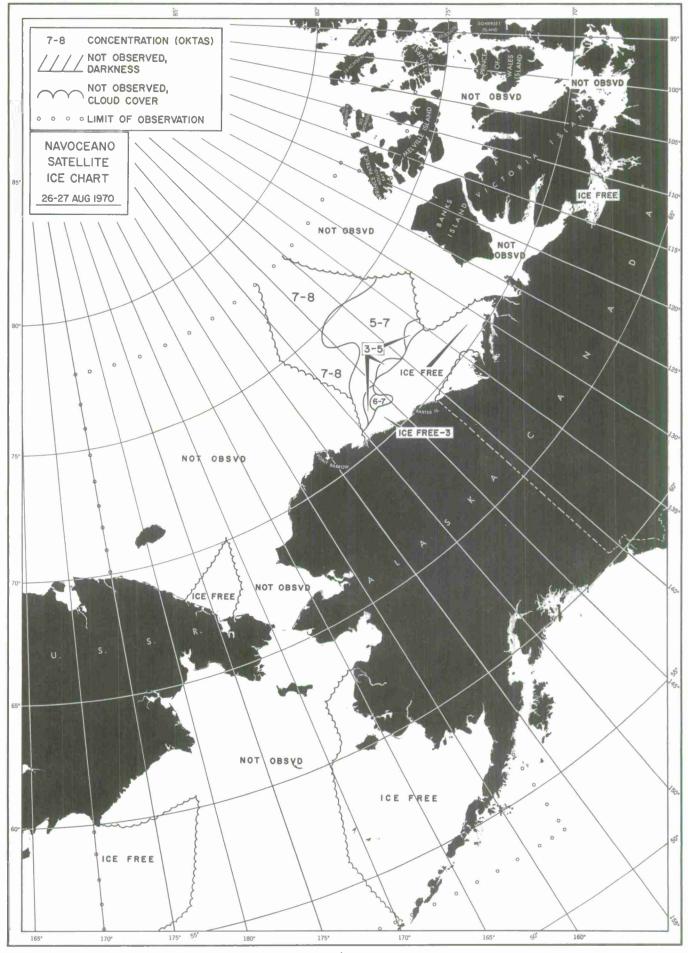


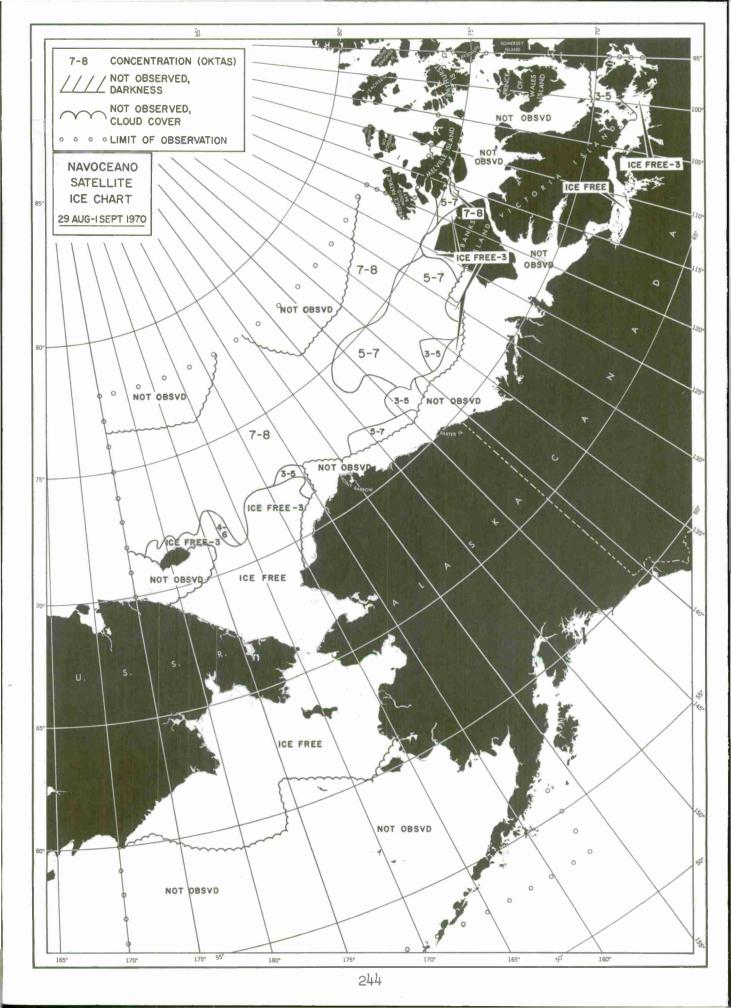


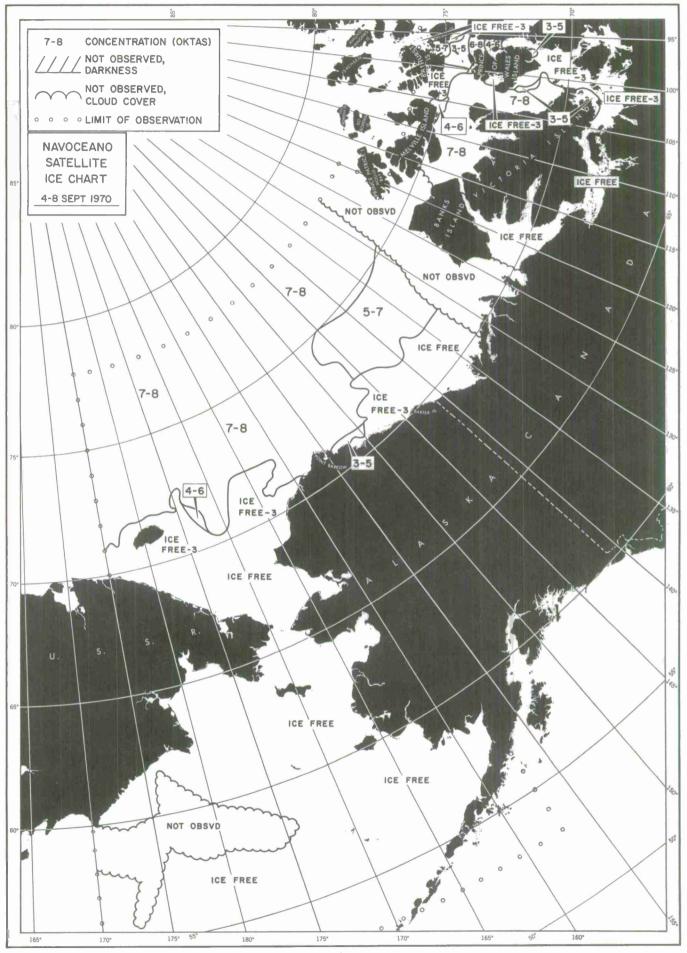


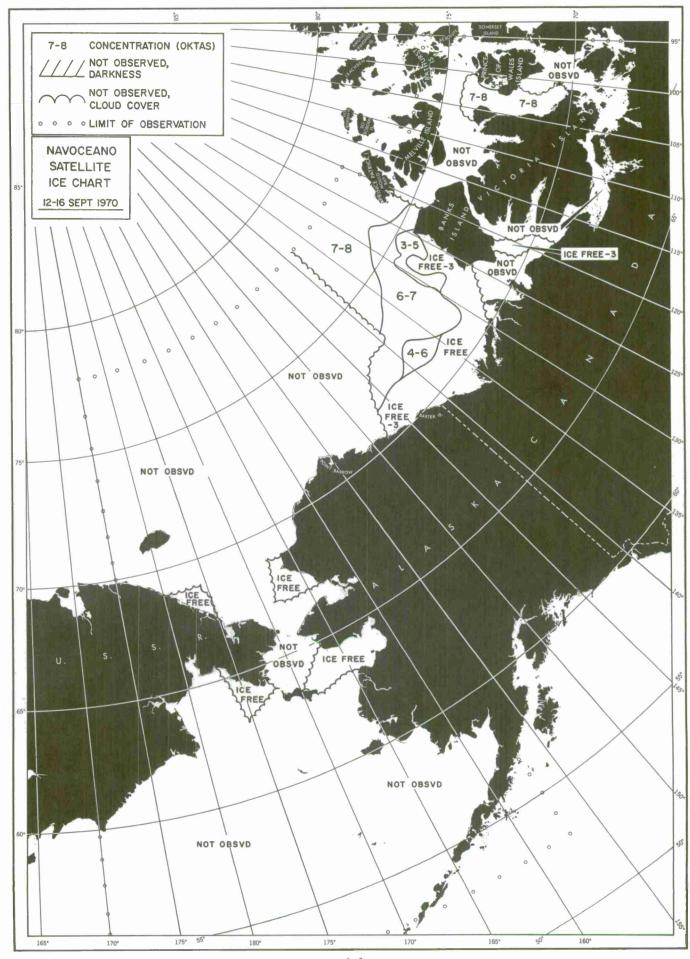


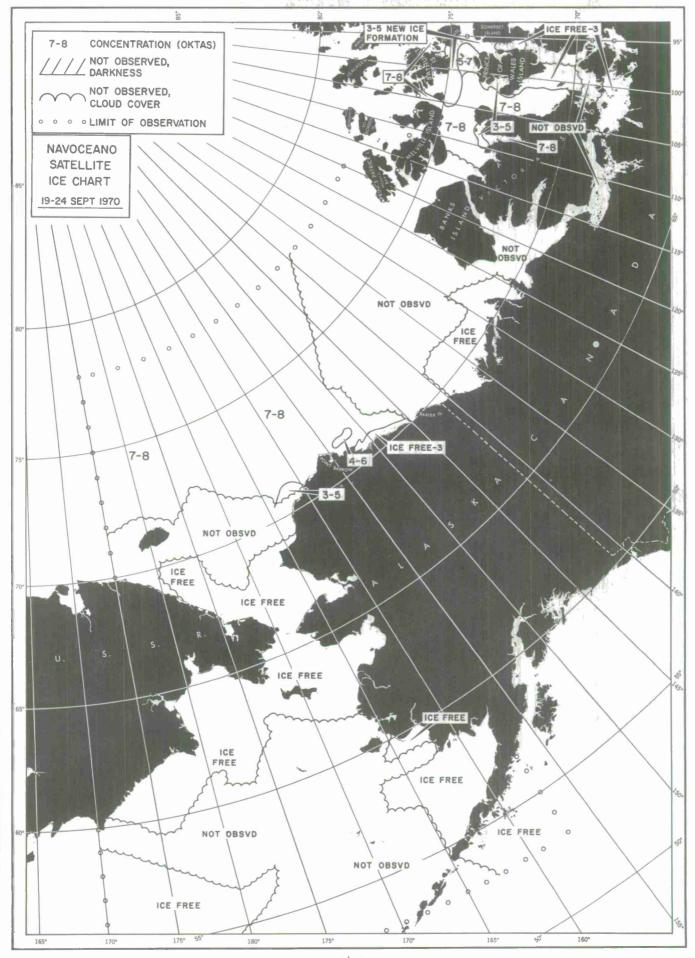


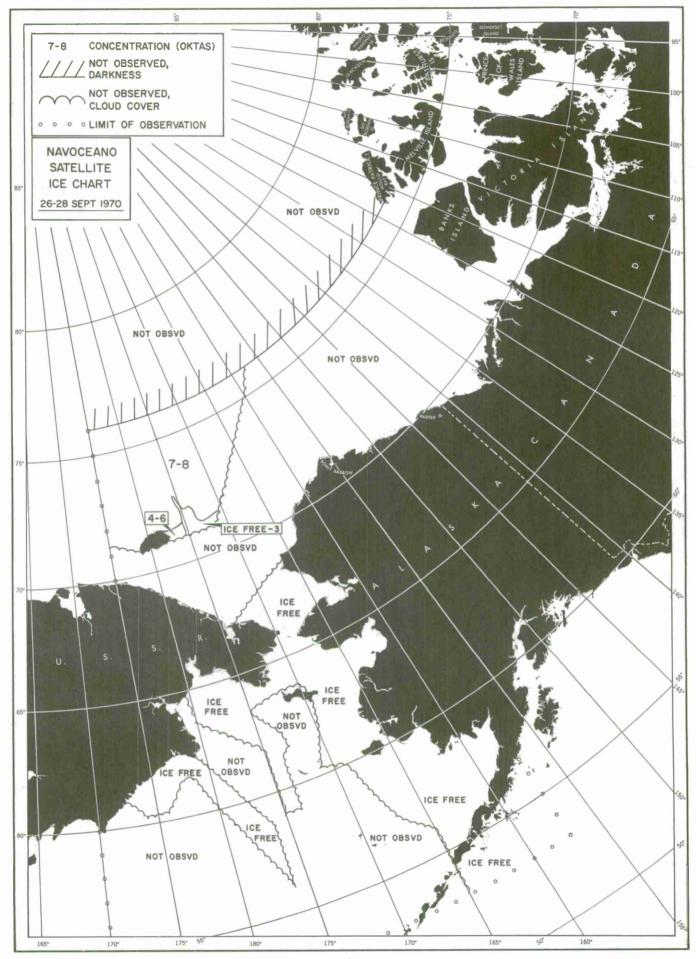


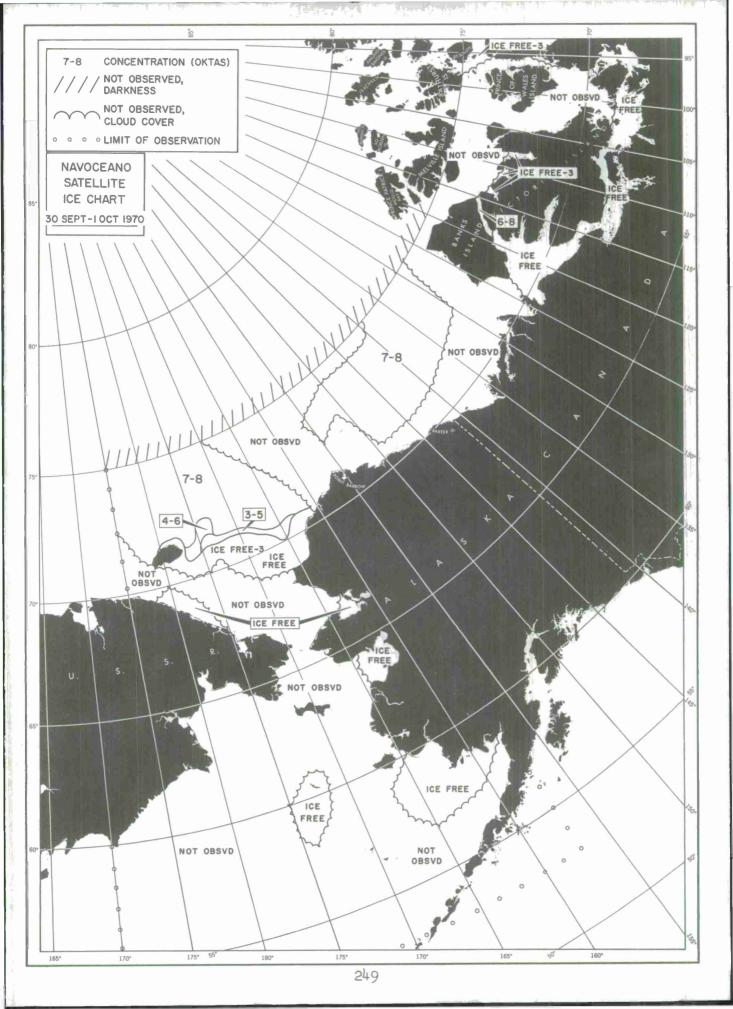












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